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Toxic and Hazardous Materials Agency

U.S. AMCCOM for U.S. Army
Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD

Revised Draft Data Collection Quality Assurance Plan for

Tooele Army Depot North Area Suspected Release RFI Phase I Study DAAA 15-90-D-0011

December 1991

JMM James M. Montgomery

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U.S. AMCCOM FOR U.S. ARMY
TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MD

REVISED DRAFT
DATA COLLECTION QUALITY ASSURANCE PLAN

FOR

TOOELE ARMY DEPOT NORTH AREA

December, 1991

Project No.: 2942.0120

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1.0 INTRODUCTION

1.0.0.1. This Data Collection Quality Assurance Plan (DCQAP) has been prepared by James M. Montgomery, Consulting Engineers, Inc. (JMM) to fulfill the requirements of Task Order 4 of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) contract DAAA-15-90-D-0011. Task Order 4 calls for a Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at the North Tooele Army Depot (N TEAD) in Tooele, Utah, as required by the State of Utah Corrective Action Permit UT3213820894.

1.0.0.2. The objective of the Phase I RFI at N TEAD is to determine if hazardous waste or hazardous constituents have been released from 20 solid waste management units (SWMUs). Task Order 4 was awarded on September 25, 1991.

1.1 PHASE I RFI SCOPE OF WORK AND DCQAP OBJECTIVES

1.1.0.1. Scope of Work. Task Order 4 requires JMM to complete a RCRA Phase I RFI at N TEAD. As summarized in Table 1-1, the Phase I RFI includes an investigation of 20 SWMUs suspected of releasing contaminants into the environment. Also included in this task are the preparation of the Phase I Work Plan and the Phase I RFI Report.

1.1.0.2. The Phase I Work Plan includes the Project Management Plan (PMP), Data Collection Quality Assurance Plan (DCQAP), Health and Safety Plan (HASP), and Data Management Plan (DMP). This document, the DCQAP, represents one element of the Phase I RFI Work Plan requirement. In accordance with the terms of the RCRA Corrective Action Permit, the DCQAP will be submitted to the Executive Secretary of the State of Utah.

1.1.0.3. The Phase I RFI Report will summarize the results of the Phase I RFI. For those SWMUs where environmental contamination is present, the report will provide recommendations for further investigation under a Phase II RFI. For those SWMUs where no contamination is found, the report will recommend that they be removed from the corrective action permit.

TABLE 1-1

SUSPECTED RELEASE SOLID WASTE MANAGEMENT UNITS (SWMU)

SWMU	Description	General Location	Comment
1	Main Demolition Area	SW Corner of N TEAD	Subarea within the Opening Burning/Open Detonation Areas
1a	Cluster Bomb Detonation Area	SW Corner of N TEAD	Subarea within the Opening Burning/Open Detonation Areas
1b	Propellant Burn Pad	SW Corner of N TEAD	Subarea within the Opening Burning/Open Detonation Areas
1c	Trash Burn Pits	SW Corner of N TEAD	
1d	Propellant Burn Pans	SW Corner of N TEAD	
4	Sandblast Areas	Maintenance Area	Buildings 615, 617, and 597
14	Sewage Lagoons	West of Maintenance Area	
19	AED Demilitarization Test Facility	West of Ordnance Area	Building 1376
20	AED Deactivation Furnace Site	West of Ordnance Area	Buildings 1351, 1352, and 1356
21	Deactivation Furnace Building	West of Ordnance Area	Building 1320
26	DRMO Storage Yard	East Side of Maintenance Area	Building 2025 and Storage Yards
27	RCRA Container Storage	Administration Area	Building 528
28	90-Day Container Storage Area	South Side of Maintenance Area	Buildings 596 and 585 and Open Storage Areas
29	Drum Storage Areas	South Side of Maintenance Area	Satellite Storage Building 576
34	Pesticide Handling and Storage Area	Maintenance Area	Building 518
37	Contaminated Waste Processing Plant	West of Ordnance Area	Building 1325

TABLE 1-1

SUSPECTED RELEASE SOLID WASTE
MANAGEMENT UNITS (SWMU)
(CONTINUED)

SWMU	Description	General Location	Comment
38	Industrial Waste Treatment Plant	West of Maintenance Area	
39	Solvent Recovery Facility	Southwest Corner of Maintenance Area	Building 600B
42	Bomb Wash Out Building	North End of Administration Area	Building 539
43	Container Storage Areas for P999	Six Igloos in Ordnance Area	Igloos B1002, C117, D304, G308, G1005, J202
44	Tank Storage of Trichloroethylene	South End of Maintenance Area	Building 620
45	Stormwater Discharge Area	Between Administration and Maintenance Areas	
46	Used Oil Dumpsters	Various Locations in Maintenance Area	Buildings 507, 509, 510, 511, 522, 602, 607, 611, 619, 620, 621, 637, and 691
47	Boiler Blowdown Water	Several Locations in Maintenance Area	Buildings 606, 610, and 637

SWMU numbering corresponds to that used in Table 8, Solid Waste Management Units with Suspected Releases, of Module VII of RCRA Corrective Action Permit UT3213820894 for the Tooele Army Depot North Area, with the exceptions of SWMU-1d and SWMU-39 which were added to this list and SWMU-41 which is excluded from this list.

1.1.0.4. **DCQAP Objectives.** The objective of this DCQAP is to present the methods that will be used to plan and execute the Phase I RFI for N TEAD in a manner consistent with USATHAMA quality assurance objectives, and State of Utah and federal requirements. The DCQAP provides guidance and specifications to ensure the following N TEAD tasks meet the stated objectives:

- Field investigations at 15 SWMUs of the 20 SWMUs listed in Task Order 4 (includes UXO clearance and geophysical survey)
- Groundwater elevation measurement survey
- Background soil sampling and analysis program
- Topographic survey.

1.1.0.5. **DCQAP Organization.** The remainder of Section 1.0 discusses project organization, responsibility, and key personnel. Section 2.0 of this plan discusses the N TEAD site history and provides a history of operations at each of the SWMUs. Information regarding each individual SWMU has been compiled from visual inspections of the SWMUs, a review of existing reports and records (including aerial photographs of N TEAD), and interviews with current and previous TEAD employees knowledgeable with the facility's operation and history. Section 3.0 discusses the environmental setting of N TEAD. Included in this section are the regional and site physiography, geology, soils, hydrology, and hydrogeology. Section 4.0 outlines the field investigative methods proposed to meet the goals of the Phase I RFI. This section also provides the rationale behind the field program and describes the field procedures that will be implemented to conduct the field investigation. Section 5.0 outlines the chemical analysis program. Included in this section are descriptions of analytical methods, laboratory protocol, and laboratory data reporting procedures. Section 6.0 outlines the Quality Assurance/Quality Control (QA/QC) procedures for both the chemical analysis program and field investigation.

1.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

1.2.0.1. JMM's team for the N TEAD task is comprised of experienced and well-qualified staff members who will be supported by personnel from Environmental Science and

Engineering, Inc. (laboratory analytical services), UXB International, Inc. (explosive ordnance clearing services), Layne Environmental Services, Inc. (drilling services), Overland Drilling (drilling services), Practical Geophysics (geophysical services), Dames and Moore, Inc. (geotechnical analysis), and Caldwell, Richards, and Sorensen (surveying). Figure 1-1 depicts the program organization and reporting responsibilities. A complete discussion of the project organization, staffing, and schedule is included in the Project Management Plan which was prepared as a companion document to this DCQAP. This section provides a brief description of JMM's role in the project and the roles of JMM's subcontractors, including their qualifications and their capabilities.

1.2.1. James M. Montgomery, Consulting Engineers, Inc.

1.2.1.1. JMM is a full service consulting engineering firm with corporate headquarters located in Pasadena, California and a staff of 1,500 located in offices throughout the country. JMM's duties for this Task Order include the following:

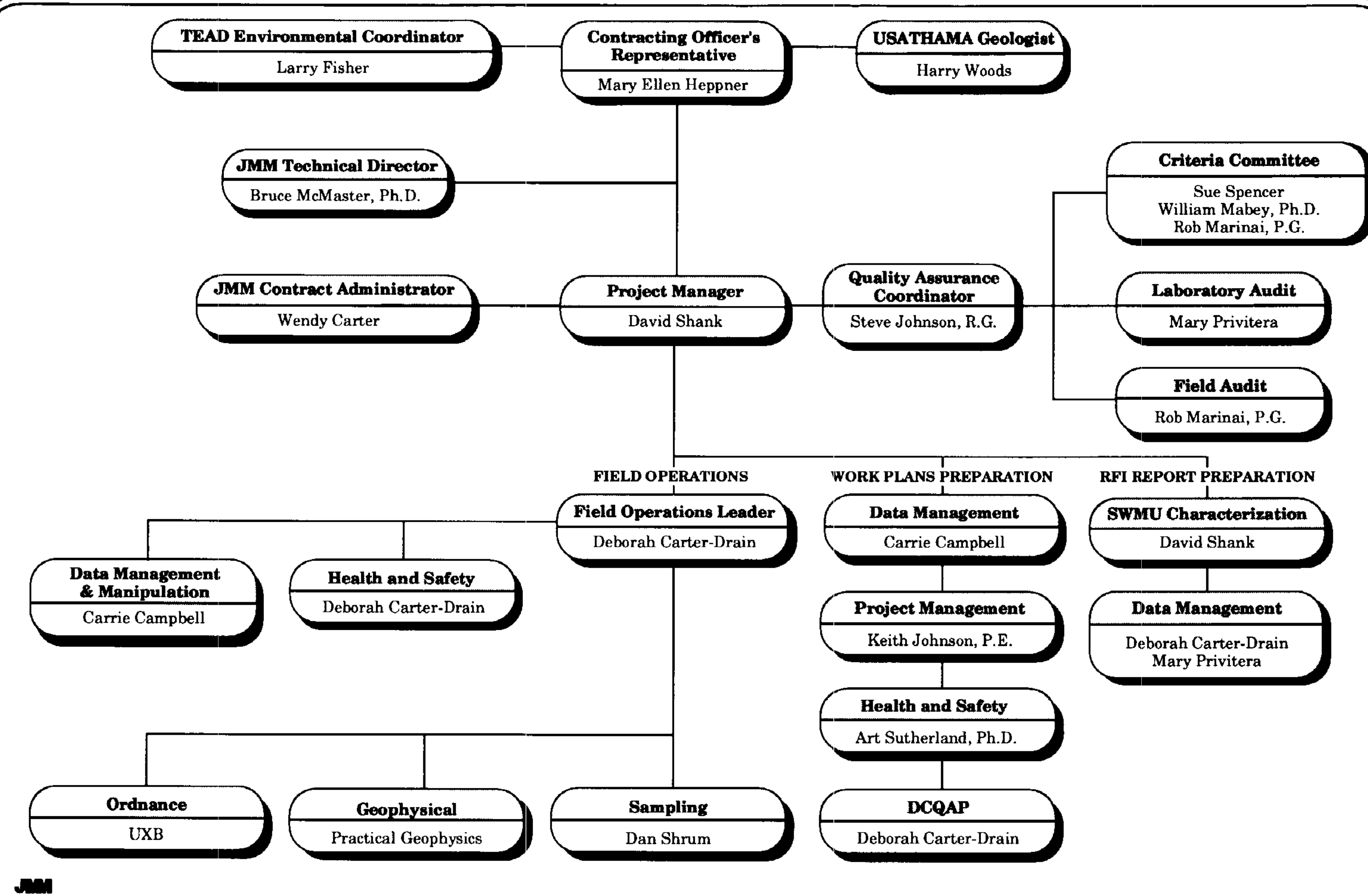
- Managing the Task Order
- Fulfilling the contract scope of work
- Implementing and managing the health and safety program
- Planning, conducting, and reporting the results of the field investigation
- Preparing the required reports
- Managing the QA/QC programs, including QA/QC audits
- Managing all project team members, including the subcontractors.

1.2.2. UXB International, Inc.

1.2.2.1. UXB International, Inc. (UXB), based in northern Virginia, provides worldwide explosive ordnance disposal services. UXB's responsibilities include:

- Conducting surface sweeps for unexploded ordnance (UXO) or other buried metal at all excavation, drilling, and geophysical survey locations in areas where UXO may be present

- Marking and identifying any on-site exposed ordnance



PROJECT ORGANIZATION
REPORTING RESPONSIBILITIES
FIGURE 1-1

- Conducting down-hole verification for the presence or absence of unexploded ordnance at boring and soil sampling locations

- Excavating test pits at the Open Burning/Open Detonation (OB/OD) Areas (SWMU-1).

1.2.3. Environmental Science and Engineering, Inc.

1.2.3.1. Environmental Science and Engineering, Inc. (ESE) Laboratory, located in Gainsville, Florida, will provide the analytical support for this project. As required by Task Order 4 ESE is certified by both USATHAMA and the State of Utah Department of Environmental Quality. The ESE Laboratory will be responsible for the analytical tasks, including electronic transfer of analytical data to JMM and entering analytical data into the Installation Restoration Data Management System (IRDMS).

1.2.4. Layne Environmental Services, Inc.

1.2.4.1. Layne Environmental Environmental Services, Inc. (Layne), based out of Mission Woods, Kansas, is a full service water well and environmental drilling company. Layne will drill eight deep boreholes for the N TEAD project in OB/OD areas. Layne will be responsible for providing drilling equipment, steam cleaning equipment, operator personnel, and for constructing a decontamination pad for the project. Layne has the type of drilling equipment needed to penetrate the coarse-granular type soils present at much of N TEAD.

1.2.5. Overland Drilling

1.2.5.1. Overland Drilling (Overland), of Salt Lake City, Utah, will drill the shallow soil borings for this project. Overland specializes in hollow stem auger drilling and has over 10 years of environmental drilling experience. Overland will provide the downhole drilling and sampling equipment and operator personnel. Overland's equipment includes all-terrain drilling rigs capable of collecting continuous-soil samples that will facilitate the subsurface sampling for this project.

1.2.6 Practical Geophysics

1.2.6.1. Practical Geophysics of Salt Lake City, Utah, will conduct the geophysical survey in the OB/OD area. Practical Geophysics will be responsible for providing and maintaining all necessary geophysical equipment and suppling the geophysical data in the appropriate format to the JMM Data Management Coordinator.

1.2.7. Dames and Moore, Inc.

1.2.7.1. The Salt Lake City, Utah, branch of Dames and Moore, Inc. will provide the geotechnical analytical support for this project. Dames and Moore will be responsible for conducting all of the geotechnical soil analyses and for providing the data in the appropriate format to the JMM Data Management Coordinator.

1.2.8. Caldwell, Richards, and Sorensen Engineering, Inc.

1.2.8.1. Caldwell, Richards, and Sorensen Engineering Inc. (CRS), based in Salt Lake City, Utah, is an inter-disciplinary consulting firm specializing in civil engineering planning, design, and construction management. CRS will conduct the location and elevation surveys at each SWMU and the N TEAD topographic survey. CRS will be responsible for presenting the data in the format required by USATHAMA and the JMM Data Management Coordinator.

1.3 KEY PERSONNEL

1.3.0.1. All project management and support staff will be from JMM's Salt Lake City, Utah, office, with the exception of the Program Manager, Bruce McMaster, Ph.D., who is based out of JMM's Walnut Creek, California office. Task Order 4 field support will also be managed from the Salt Lake office. Support staff from other JMM offices will be provided as required.

1.3.0.2. The structure of the project's overall technical organization is shown in Figure 1-1. This structure was selected to provide responsive technical management, to establish and maintain schedules, to maintain established quality control standards, to provide adequate health and safety protection, to establish and maintain effective coordination with USATHAMA, and to control costs. The key individuals identified in Figure 1-1 were selected based on their previous experience with hazardous waste management programs, and their management and technical abilities. The responsibilities and qualifications of key positions are outlined in the following sections.

1.3.1. USATHAMA Project Officer

1.3.1.1. Ms. Mary Ellen Heppner is the contracting officer's representative and will represent USATHAMA as the overall project manager for this task order. Her responsibilities include coordinating between TEAD representatives and JMM and communicating with the State of Utah representatives on project matters.

1.3.2. USATHAMA Geologist

1.3.2.1. USATHAMA has assigned Mr. Harry Woods of Argon National Laboratories, to this project to provide geological expertise in the review of all field work and contractor-generated reports. He will work closely with USATHAMA's project officer to ensure that the field program meets USATHAMA standards and that all reports and work plans meet the objectives of the N TEAD Phase I RFI.

1.3.3 Program Manager

1.3.3.1. Bruce McMaster, Ph.D., of JMM is the N TEAD technical director and the program manager of JMM's total environmental support contract with USATHAMA. He has over nine years of experience managing hazardous waste site remediation projects for the Department of Defense and industrial clients. Dr. McMaster will have total responsibility of the project which includes the overall direction, coordination, technical consistency, and review of the N TEAD project. He will assure that all QA/QC controls are established at the beginning of the project, and will ensure from a corporate level that all resources necessary to complete the project are available.

1.3.4. Project Manager

1.3.4.1. Mr. David Shank, a Senior JMM Hydrogeologist, will be the N TEAD Project Manager. Mr. Shank has over 10 years of experience investigating and managing industrial and Department of Defense hazardous waste projects. Mr. Shank will report to the Program Manager and is responsible for setting project goals and directing technical resources for the satisfactory completion of the DCQAP objectives. He is also responsible for day to day technical management of project staff and direct communication and liaison with the program management team. He is responsible for coordination, preparation, and approval of all project deliverables and will represent the project team at project-related meetings.

1.3.5. Health and Safety Coordinator

1.3.5.1. Mr. Steven Glaser will be the Health and Safety Coordinator for this project. Mr. Glaser is the Regional Health and Safety Officer for JMM's Central Region-West. His project responsibilities include reviewing the the Health and Safety Plan (HASP) and working with the project manager and on-site safety officer to ensure all health and safety requirements, as outlined in the HASP, are implemented during the field investigations. Mr. Glaser also will be responsible for monitoring any health and safety programs that relate to N TEAD, providing on-call assistance to the field team members, and modifying, if necessary, the health and safety program.

1.3.6. Explosive Ordnance Disposal Officer

1.3.6.1. Mr. Tom Yancey of UXB will coordinate explosive ordnance clearance during the field program at N TEAD. Mr. Yancey will have complete control and responsibility for the overall coordination, scheduling, safety, and completion of ordnance operations. He will interface with the Health and Safety Coordinator and Army representatives and will have the authority to deal directly with TEAD personnel regarding all explosive ordnance disposal issues.

1.3.7. Data Management Coordinator

1.3.7.1. Ms. Carrie Campbell of JMM is the Data Management Coordinator. Ms. Campbell is a Senior Environmental Scientist and specializes in data collection and computerized database management. Ms. Campbell's responsibilities include preparing the Data Management Plan, overseeing the operation of the data management system, and establishing procedures for the electronic delivery of all data into the USATHAMA IRDMS database.

1.3.8. Field Operations Leader/On-Site Safety Officer

1.3.8.1. Ms. Deborah Carter-Drain, a JMM Soil Scientist will serve a dual role as the Field Team Leader and the On-site Safety Officer. Ms. Drain will be responsible for ensuring that field procedures outlined in this DCQAP are implemented and conducted according to the procedures and precautions described in the HASP. She will provide field supervision for all subcontractors associated with the N TEAD field program and will be responsible for directing field crew activities, maintaining daily logs of site activities, and recording pertinent data.

1.3.9. Quality Assurance Coordinator

1.3.9.1. Mr. Steve Johnson of JMM is the project quality assurance coordinator. Mr. Johnson is a Registered Geologist and has over 13 years of experience in designing, implementing, and managing investigations at industrial and military CERCLA and RCRA sites. Mr. Johnson is very familiar with N TEAD after serving as the project manager for the Groundwater Quality Assessment at the industrial waste lagoon. As the Quality Assurance Coordinator for the N TEAD project, Mr. Johnson will work closely with the project manager to ensure that the Project Plans, the RFI reports, and the sampling and analysis of all matrices during the N TEAD program are carried out in accordance with the requirements of the USATHAMA quality assurance program (USATHAMA, 1990) and the State of Utah. Mr. Johnson will also review data submittals from the analytical laboratory and direct quality assurance audits of both the field operations and laboratory activities during the project.

2.0 SITE BACKGROUND

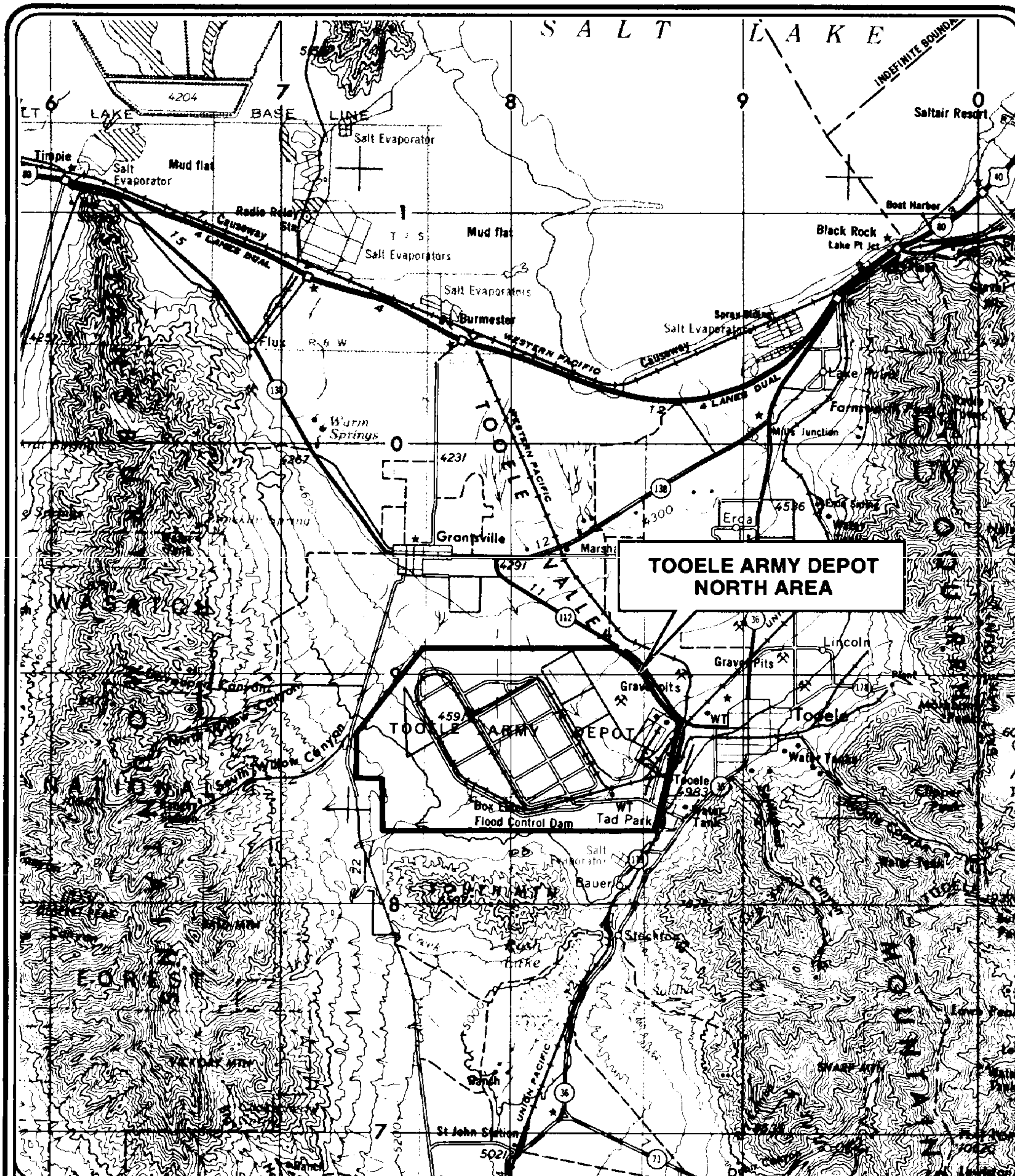
2.0.0.1. The following sections present the site background and physical setting of N TEAD and provide the framework under which the Phase I RFI Work Plans were developed.

2.1 OVERVIEW OF TOOELE ARMY DEPOT, NORTH AREA

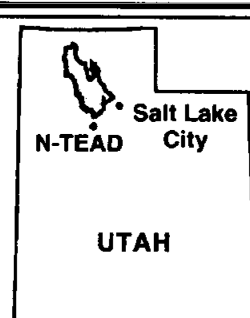
2.1.0.1. N TEAD encompasses 24,700 acres in the Tooele Valley in Tooele County, Utah (Weston, 1990a). It is located approximately 17 miles north of S TEAD and 35 miles southwest of Salt Lake City. The Tooele Valley is bounded to the south by the Stockton Bar and South Mountain, to the west by the Stansbury Mountains, to the east by the Oquirrh Mountains, and to the north by the Great Salt Lake. The city of Grantsville (1991 population 4,500) is approximately 2 miles north of N TEAD, and the city of Tooele (1991 population 13,887) is located immediately to the east. The location of N TEAD is depicted in Figure 2-1.

2.1.0.2. N TEAD was established as Tooele Ordnance Depot on April 7, 1942, by the U.S. Army Ordnance Department. During World War II, TEAD was a backup depot for the Stockton Ordnance Depot and Benicia Arsenal, both in California. Vehicles, small arms, and other equipment for export were stored at TEAD. It was redesignated as N TEAD in August 1962. The developed features of N TEAD may be grouped into four main areas: (1) the ammunition storage igloos and magazines, (2) the administrative buildings, (3) the industrial maintenance area, and (4) the open revetments. Figure 2-2 depicts the N TEAD facility, the location of the 20 SWMUs included in this study, and the general areas described above.

2.1.0.3. The Tooele Army Depot (North and South Area combined) is one of the major ammunition storage and equipment maintenance installations in the U.S., and supports other Army installations throughout the western United States. The current mission of N TEAD is to receive, store, issue, maintain, and dispose of munitions; to provide installation support to attached organizations; and to operate other facilities, as assigned. Its major functions include the following:



Source: USGS Tooele, Utah 1° x 2° Quadrangle, 1970



N

0 1 2 3 4 5

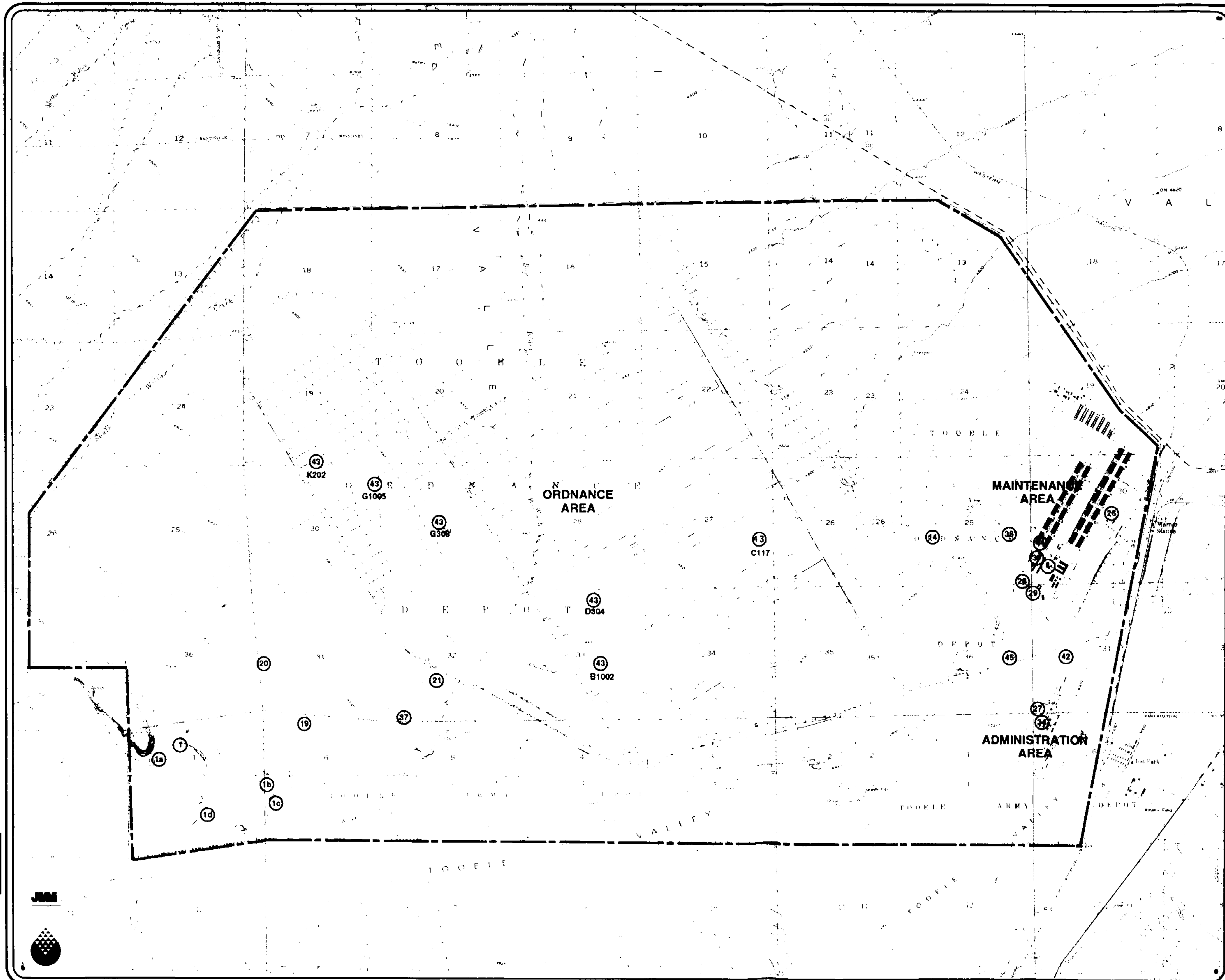
Scale in Miles

JMM

SITE LOCATION MAP

FIGURE 2-1

PROJECT NO. 2942.0120



EXPLANATION

- 1 Open Burning/Open Detonation Areas
- 4 Sandblast Area
- 14 Sewage Lagoons
- 19 AED Demilitarization Test Facility
- 20 AED Deactivation Furnace Site
- 21 AED Deactivation Furnace Building
- 26 DRMO Storage Yard
- 27 RCRA Container Storage Yard
- 28 90-Day Drum Storage Area
- 29 Drum Storage Areas
- 34 Pesticide Handling and Storage Area
- 37 Contaminated Waste Processing Plant
- 38 Industrial Waste Treatment Plant
- 39 Solvent Recovery Facility
- 42 Bomb Washout Building
- 43 Container Storage for P999 (igloo numbers indicated)
- 44 Tank Storage for TCE
- 45 Stormwater Discharge Area
- 46 Used Oil Dumpsters
- 47 Boiler Blowdown Areas

Note: *The locations or various SWMUs 46 (Used Oil Dumpsters) and 47 (Boiler Blowdown Water areas) are not shown although they are present at several locations in the administration and maintenance areas.*

0 4000
Scale in Feet

N TEAD PHASE I RFI SOLID WASTE MANAGEMENT UNIT LOCATION MAP

FIGURE 2-2

PROJECT NO. 2942.0120

- Supply, distribute, and store general supplies and ammunition
- Store strategic and critical materials
- Maintain ammunition and general supplies for N TEAD
- Demilitarize ammunition
- Supervise training of assigned units and provide logistical support and training assistance to U.S. Army Reserves
- Design, manufacture, procure, store, and test ammunition equipment
- Repair, maintain, and store military vehicles.

2.2 INDIVIDUAL SWMU HISTORIES AND SITE CONDITIONS

2.2.0.1. A SWMU is defined as any discernable unit at which solid or hazardous wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste (USEPA, 1989). In December 1987, under contract to the U.S. Environmental Protection Agency (EPA), Region VIII, the NUS Corporation published a Final Interim RCRA Facility Assessment for the North Area (NUS, 1987). This report identified 28 SWMUs and made recommendations regarding investigations that should be conducted to assess potential threats to the public health and the environment. Since 1987, 18 additional SWMUs have been identified at N TEAD.

2.2.0.2. On January 7, 1991, a Corrective Action Permit (CAP) for the SWMUs in N TEAD was issued by the State of Utah and EPA Region VIII. The CAP requires the Army to perform a RCRA Facility Investigation at 46 SWMUs listed in the permit. For administration purposes, corrective actions for the SWMUs were divided into three groups: those with suspected environmental releases with the State of Utah as the lead agency, those with known environmental releases with the USEPA as the lead agency, and those that are administered jointly by the State of Utah and the USEPA under a Federal Facilities

Agreement. This DCQAP refers only to the 20 suspected release SWMUs listed in Table 1-1.

2.2.0.3. A series of environmental investigations were performed at N TEAD between 1979 and 1991. These projects ranged from general environmental surveys of the area to remedial investigations (RIs) and preliminary risk assessments. Table 2-1 summarizes these investigations, and includes the objective, scope, and conclusions of each investigation. The following sections provide a site description and summary of available information regarding suspected releases for each SWMU. In addition, specific details of the previous environmental investigations as they relate to each SWMU are provided. Much of this material is taken from the Tooele Army Depot, North-Area Site Investigation and Follow-On Remedial Investigation Final Site Investigation Work Plan prepared for USATHAMA by E. C. Jordan Co. (Jordan, 1990a and 1990b, respectively).

2.2.1. Open Burning/Open Detonation Areas (SWMU-1)

2.2.1.1. OB/OD Site Locations and Descriptions. The Open Burning/Open Detonation (OB/OD) Areas are in the southwest corner of N TEAD in the Ordnance Area. This SWMU consists of five separate subareas including the Main Demolition Area (Area 1) and Cluster Bomb Detonation Area (Area 1a), the Propellant Burn Pad (Area 1b), the Trash Burn Pits (Area 1c), and a Propellant Burn Pan Area (Area 1d). All five of the OB/OD subareas are shown in Figures 2-3 and 2-4. Current use of these sites at the N TEAD OB/OD Areas is limited to the emergency detonation of bombs in the Main Demolition Area, and burning propellents in eight newly installed propellant burn pans in the Propellant Burn Pan Area. According to available information, chemical warfare agents have not been stored, processed, or handled at this location or any other N TEAD location.

2.2.1.2. Previous Investigations. The OB/OD Areas were the subject of a four-phase investigation by the U.S. Army Environmental Hygiene Agency (AEHA), conducted from 1981 through 1984. The investigation evaluated the impacts of OB/OD areas on the environment to determine which OB/OD facilities should continue to be used. Phase I of the AEHA investigation was an initial screening to determine which OB/OD facilities warranted sampling and analysis (AEHA, 1982). Phase II consisted of sampling and analyzing surface and near-surface soils for Extraction Procedure Toxicity (EP Toxicity) of metals and selected explosives (AEHA, 1983) at each N TEAD OB/OD site. Phase III

TABLE 2-1

SUMMARY OF PREVIOUS INVESTIGATIONS AT N TEAD

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
December 1979	Environmental Assessment of Tooele Army Depot, Report No. 141. (for USATHAMA)	Assess environmental quality of TEAD with regard to use, storage, treatment, and disposal of hazardous materials and define any possible public health concerns.	Conducted a records review to identify major source areas.	The potential for chemical migration exists at both N-TEAD and S-TEAD. Major chemicals of concern: chemical agents, plating rinse waters, and explosive residues.	None
June 1982	Installation Environmental Assessment (Inland Pacific Engineering Co. under USACE)	Define TEAD activities and their potential environmental impact.	Described TEAD activities, facilities, and the surrounding environment. Conducted inventory indigenous flora and fauna at N-TEAD.	Summary of environmental, human, and economic impact in the event of closure and/or clean-up.	None
1982-1985	Investigation at the Open Burning/Open Detonation Areas (AEHA)	Evaluate potential for environmental contamination at OB/OD areas at army depots nationwide with respect to federal regulations. Determine which areas should be used for continued OB/OD operations.	Established the potential for soil, surface water, ground-water, and surface soil contamination via records review and limited sampling of potential source media.	Soil study indicated no remedial action necessary. No OB/OD Areas closed as a result of study. Metals of concern are: PB, CD, and BA.	Full hydrogeological evaluation needed to assess public health risk of 246TNT, RDX, and HMX in groundwater.
1982	Exploratory Environmental Contamination Assessment Report (ERTEC)	Identify potential source areas at both N-TEAD and S-TEAD.	Phase I: used existing data to identify SWMUs of concern. Phase II: installed monitoring wells, performed geophysical surveys, and sampled/analyzed soil, sediment, and GW/SW at SWMUs with greatest contamination potential.	Minimal contamination and migration in all media. The IWL plume was identified (ZN, CL, F, PO4, NA, 12DCLE, T12DCE, TRCLE, and 246TNT). Plume migration path is towards N-TEAD Supply Well No. 2. Estimated time to reach northern boundary of N-TEAD: 55 years from 1982.	The vertical and horizontal distribution of chemicals in the IWL plume and potential risk to public health need to be assessed.
May 1983	Analysis of Existing Facilities/Environmental Assessment Report (TEAD Facilities Engineering)	Identify and summarize activities and/or missions associated with TEAD and perform an environmental assessment of these activities.	Described major activities, cultural elements, and environmental characteristics surrounding TEAD.	No conclusion or recommendations for further study were presented.	None

TABLE 2-1

SUMMARY OF PREVIO''S INVESTIGATIONS AT N TEAD
(CONTINUED)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
January 1985	Monitoring Activity and Waste Disposal Review and Evaluation (CH2M Hill)	Determine adequacy of Phase I and II investigations (ERTEC) as well as determine if adequate information is available to support an FS.	Reviewed all available data to determine existence of data gaps.	Data deficiencies identified in the Ertec Phase II report. Sample/analyze all existing monitoring and water supply wells on a semiannual basis. Sample/analyze Well No. 1 and have results reviewed by medical community to determine possible health risks due to chemicals in groundwater.	Geologic, chemical, and hydrologic conditions throughout TEAD must be evaluated. Install two wells north of TNT Washout Facility.
March 1985	A Study of Environmental Balance (Department of Army)	Describe the environmental management program at TEAD.	Developed ecological profile of TEAD as well as present TEAD's goals with respect to air, water, solid waste, radiation, and hazardous materials management.	Further environmental controls are necessary at TEAD to prevent chemical releases.	None
March 1985	Performance of Remedial Response Activities at Uncontrolled Hazardous Waste Sites - Final Plan (CDM)	Review documents developed for or by the DOD and make recommendations regarding documents' completeness.	Discussed technical support and potential approaches to site remediation.	A guide to implementing alternative remedial actions at TEAD.	None
1985	Interim Groundwater Quality Assessment Report (Woodward-Clyde)	Assess the distribution of chemicals in groundwater in the vicinity of the unlined IWL and connecting ditches.	Sampled/analyzed lagoon liquid, lagoon sludge, and soils surrounding the lagoon and ditches. Sampled/analyzed existing monitoring wells and water supply wells n the vicinity of the IWL.	Contamination of groundwater downgradient of IWL. Identified sources include surface water, sludge, and soil containing various VOCs, SVOCs and metals. VOCs only detected in groundwater	Interim monitoring of existing and proposed wells to further characterize the distribution of chemicals in groundwater.
November 1985	Analytical/Environmental Assessment Report (TEAD Facilities Engineering)	Summarize conclusions of previous studies and assess potential environmental impact due to future development plan.	Updated site maps and study existing land use to determine accuracy of existing Preservation Plan. Collected and analyzed new data including interviews with security, traffic control, and health services personnel.	No currently proposed project at TEAD presents long-term or irreversible negative impacts on the Tooele Valley environment.	None

TABLE 2-1

SUMMARY OF PREVIOUS INVESTIGATIONS AT N TEAD (CONTINUED)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
January 1986	Industrial Wastewater Lagoon and Ditches - Groundwater Quality Assessment Report, Corrective Action Plan, and Record of Decision (JMM)	Define the extent and magnitude of groundwater contamination associated with the IWL.	Phase I - characterized geologic conditions and groundwater flow (31 piezometers). Phase II - determined the distribution of chemicals in groundwater (25 monitoring wells). Phase III - evaluated remedial alternatives.	TCE was the predominant chemical. Highest concentrations were found adjacent to the wastewater ditches south of the IWL. Remediation would occur at the northern end of the N-TEAD using extraction wells, an air stripper, and injection wells. Estimated time for remediation - 30 years.	Additional monitoring wells needed to further characterize groundwater quality.
March 1986	Engineering Report for Closure of the Industrial Waste Lagoon (JMM)	Assess feasible alternatives for closing the IWL with respect to cost, effectiveness, and regulatory compliance and develop necessary engineering analyses for closure.	Provided a description of the distribution of source chemicals, discussed available treatment processes, and recommended a closure approach.	The report concluded that for source soils and sludges at the IWL: (1) removal and off-site disposal, or (2) removal to new, on-site disposal facility were most feasible remedial alternatives.	None
July 1986	Environmental Photographic Interpretation Center Report (USEPA and EPIC)	Identify possible areas of past use, storage, treatment and disposal of toxic and hazardous materials.	Acquired archival black and white aerial photographs for approximately five-year intervals between 1940 and 1981.	Black and white enlargements of seven significant areas were provided.	None
August 1987	Draft Interim RCRA Facility Assessment (NUS)	Evaluate releases of hazardous wastes and identify corrective actions and/or necessary investigations.	Reviewed existing USEPA files (desktop survey) to verify characteristics of SWMUs and identify additional SWMUs.	Continued and first-time sampling at several SWMUs; including IWL, X-ray Lagoon Pole Transformer PCB Spill Site, TNT Washout Facility, Pesticide/Herbicide Handling and Storage Building, Sewage Lagoons, Sanitary Landfill, and Battery Pit.	Continued sampling at investigated SWMUs. Missing historical data and radiological survey needed.
May 1988	Groundwater Quality Assessment Engineering Report (JMM)	Additional characterization of groundwater quality in IWL areas.	Installed 12 monitoring wells and continued sampling/analysis of 19 existing wells for VOCs, selected metals, and major cations and anions.	Major VOCs (TRCLE, 111TCA, and CCL4) detected in N-TEAD monitoring wells. Major cations and anions, however, were found to increase in concentration with depth and distance along groundwater flow lines.	Six additional monitoring wells are needed to evaluate the distribution of chemicals in unmonitored zones (250-450 feet BGS).

TABLE 2-1

SUMMARY OF PREVIOUS INVESTIGATIONS AT N TEAD (CONTINUED)

Report Issue Date	Investigation Title (Study Lead)	Objective	Scope	Conclusions and/or Recommendations	Identified Data Needs
1988	Preliminary Assessment/Site Investigation Report (EA)	Identify N-TEAD SWMUs that present a known or potential threat to public health or the environment.	Reviewed existing databases for potential source information. Conducted an on-site inspection. Installed 5 monitoring wells and 4 lysimeters and sampled/analyzed existing monitoring wells, surface soil, and/or sediment for explosives, metals, VOCs, and SVOCs.	Explosives detected in soils and sediments at the TNT Washout Facility. Recommendations include: N-TEAD should discontinue or relocate the laundry facility or install and impermeable liner beneath the pond and inspect the liner at the X-ray Lagoon.	Necessary monitoring wells: TNT Washout Facility, Drum Storage Areas, Chemical Range, Old Burn Area, and X-ray Lagoon. Soil borings at TNT washout Facility.
1990	Draft Final Remedial Investigation Report (WESTON)	Summarize previous investigations. Review data collected and previous conclusions. Identify and investigate data gaps for the TNT Washout Facility, Chemical Range, Old Burn Area, Sanitary Landfill, and Drum Storage Areas.	Reviewed existing data and implemented an extensive field program consisting of 30 boreholes for soil characterization and 28 monitoring wells. Performed an extensive geophysical survey. Analyzed groundwater, soil samples for VOCs, SVOCs, metals, explosives, and major cations and anion	Contamination assessment indicated low concentrations of explosives in shallow soils surrounding the TNT Washout Facility. VOCs C6H6, 12DCE, TRCLE were detected in groundwater at the Sanitary Landfill. Surface soil/groundwater contamination at the Drum Storage Areas was limited. Surface soil samples from the Chemical Range and the Old Burn Area exhibited low concentrations of metals.	Additional monitoring wells are required to characterize the perched groundwater zone at the TNT Washout Facility and between the Sanitary Landfill and Sewage Lagoons. Continued sampling of existing wells recommended.
1991	Groundwater Quality Assessment for Tooele Army Depot Tooele, Utah (ESE)	Provide additional data regarding groundwater elevations and provide analytical data for the Groundwater Quality Assessment of the IWL for corrective actions evaluation.	Collect groundwater elevation measurements from 140 existing piezometers and monitoring wells, and collect and analyze groundwater samples for VOCs from 26 existing monitoring wells.	Conditions at TEAD are very similar to results from previous investigations. Groundwater flowgradient is in a north to northwest direction. The contaminants detected during this investigation and the TRCLE plume position are similar to results of the 1988 (JMM) and 1990 (Weston) investigations.	None

TABLE 2-1

SUMMARY OF PREVIOUS INVESTIGATIONS AT N TEAD (CONTINUED)

Study Lead Acronyms:

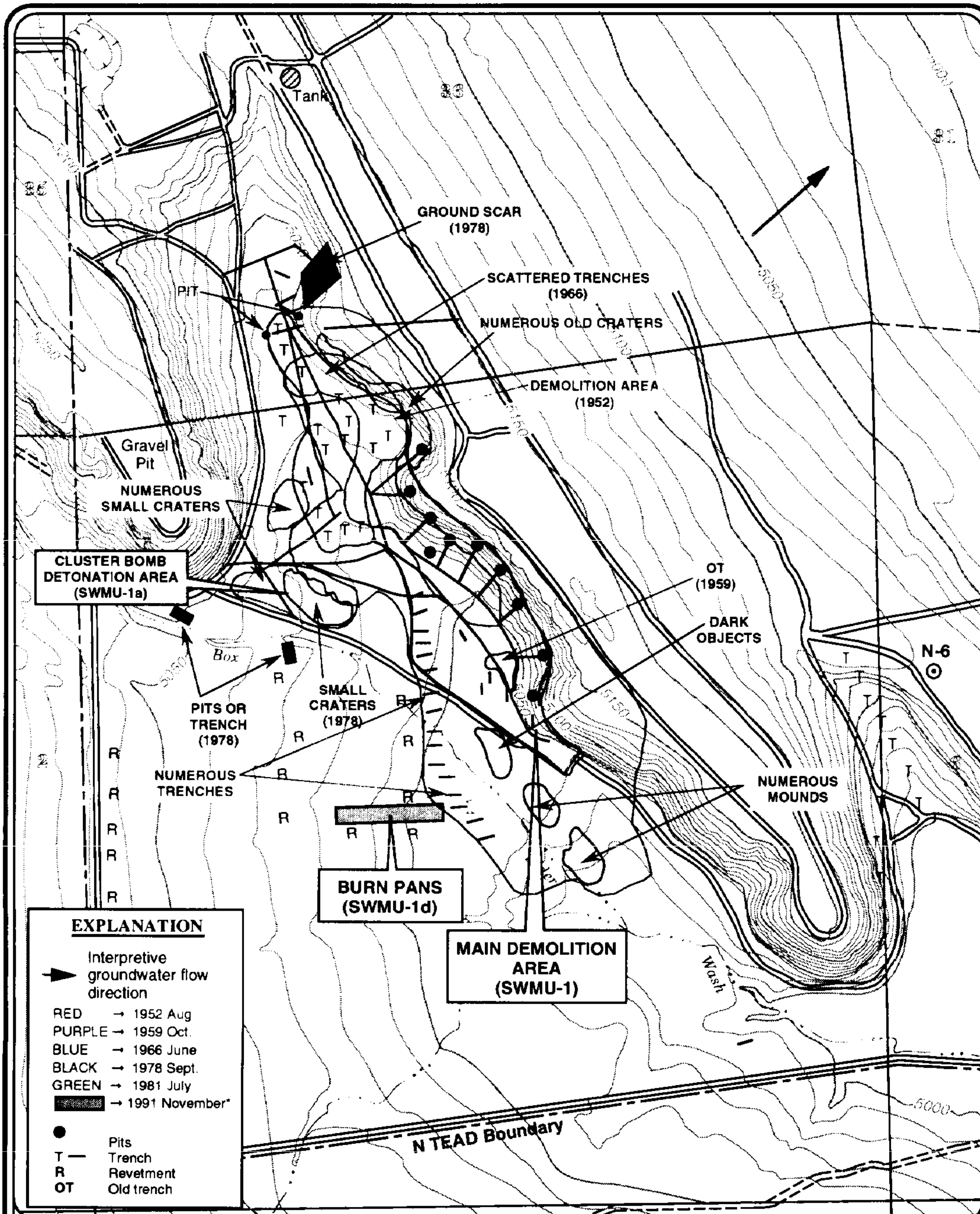
AEHA - Army Environmental Health Agency
CDM - Camp, Dresser & McKee, Inc.
EA - EA Engineering, Science and Technology Inc.
EPIC - Environmental Photographic Interpretation Center
ERTEC - Ertec Western, Inc.
JMM - James M. Montgomery Consulting Engineers, Inc.
NUS - NUS Corporation
USACE - U.S. Army Corps of Engineers
USATHAMA - U.S. Army Toxic and Hazardous Materials Agency
USEPA - U.S. Environmental Protection Agency
WESTON - Roy F. Weston, Inc.
Woodward-Clyde - Woodward-Clyde Consultants
ESE - Environmental Science and Engineering, Inc.

Miscellaneous Acronyms:

BGS - Below Ground Surface
DOD - Department of Defense
EPA - Environmental Protection Agency
FS - Feasibility Study
GW/SW - Groundwater/Surface Water
IWL - Industrial Waste Lagoon
N-TEAD - Tooele Army Depot, North Area
OB/OD - Open Burning/Open Detonation
PCB - polychlorinated biphenyl
RCRA - Resource Conservation and Recovery Act
S-TEAD - Tooele Army Depot, South Area
SWMU - Solid Waste Management Unit
SVOCs - Semivolatile Organic Compounds
TEAD - Tooele Army Depot
TCE - trichloroethylene
VOCs - Volatile Organic Compounds

USATHAMA Chemical Codes:

BA - barium
CCL4 - carbon tetrachloride
CD - cadmium
CL - chloride
C6H6 - benzene
F - fluoride
BMX - cyclotetramethylenetetranitramine
HA - sodium
PB - lead
PO4 - phosphate
RDX - cyclonite
TRCLE - trichloroethylene
T12DCE - trans-1,2-dichloroethylene
ZN - Zinc
111TCA - 1,1,1-trichloroethane
12DCE - 1,2-dichloroethylene
12DCLE - 1,2-dichloroethane
246TNT - 2,4,6-trinitrotoluene



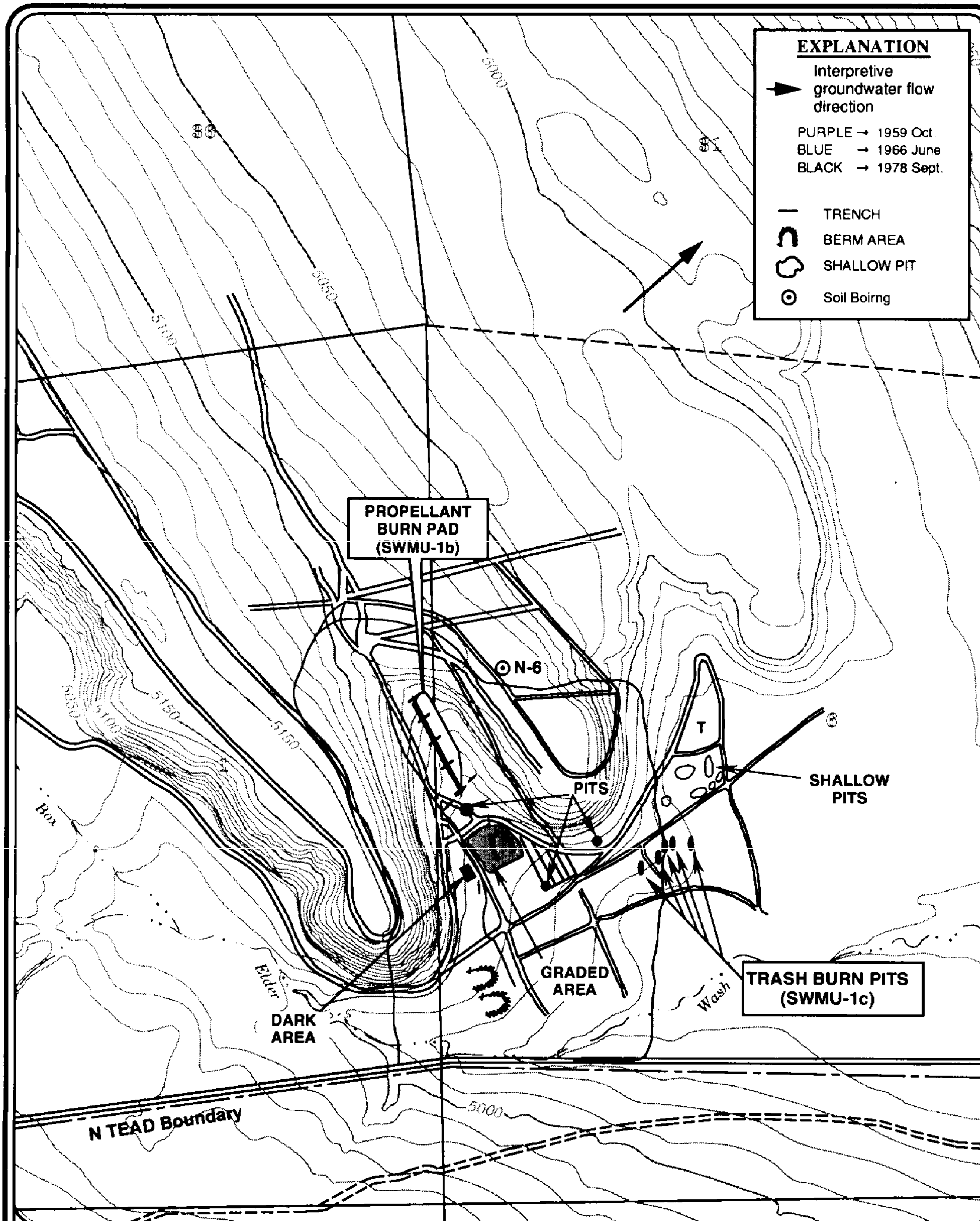
Source: Modified from USGS Grantsville and Stockton 7.5 minute quadrangles.

* Burn pan locations during site visit in November 1991.

0 1000
Scale in Feet

SWMU-1, -1a AND -1d
OPEN BURN/
OPEN DETONATION AREA
FIGURE 2-3

PROJECT NO. 2942.0120



Source: *Modified from USGS Grantsville and Stockton 7.5 minute quadrangles.*

0 1000
Scale in Feet

SWMU-1b, -1c
OPEN BURN AREAS
FIGURE 2-4

PROJECT NO. 2942.0120

summarized and compared results from all OB/OD areas sampled during Phase II (AEHA, 1984). Phase IV consisted of additional sampling and analysis of soils at selected locations, including the Trash Burn Pits (AEHA, 1985). The following sections describe the physical setting of each of five OB/OD subareas and provide a history of each, including results of previous sampling efforts.

2.2.1.3. Physical Setting. The OB/OD subareas are located in valleys between several small hills in the southwest corner of N TEAD. The hills tend to isolate the subareas from the rest of the depot and appear to be well developed gravel bars deposited by Lake Bonneville. In 1981, ERTEC, Inc. drilled soil boring N-6 on top of one of the hills to a depth of 709 feet in the vicinity of the OB/OD Areas (Figure 2-4) (ERTEC, 1982). The boring encountered coarse granular soils as follows:

- Zero to 100 feet bgs: Sands and gravels
- 100 to 200 feet bgs: Silty sands, gravels, and sandy clayey silt
- 200 to 500 feet bgs: Gravelly sands and sandy gravels
- 500 to 670 feet bgs: Gravels
- 670 to 709 feet bgs: Clayey sandy gravels.

2.2.1.4. Soil boring N-6 did not encounter the regional water table; therefore, the depth to groundwater is greater than 710 feet below ground surface in this area. The OB/OD Areas are reportedly located at the margin of a seasonal groundwater recharge area. During years of high precipitation, melting snow in the spring extends from the regional recharge areas along the Stansbury Mountains into the OB/OD Areas (AEHA, 1983). The only surface water present in the OB/OD Areas occurs infrequently in Box Elder Wash during high precipitation/runoff periods. No ponds or lagoons are present in the OB/OD Areas.

2.2.1.5. Main Demolition Area (SWMU-1). At the Main Demolition Area (Figure 2-3), which is located at the base of a steep hill, all types of munitions, from small arms projectiles to 12,000-pound bombs have been detonated. This area has been active since about 1942 and the amount of munitions treated varies widely from year to year. According to the N TEAD ammunition directorate, the area was used only occasionally during 1985 to 1988. By contrast, during 1990, approximately 9,000 tons of munitions were treated (Rutishauser, 1991). To detonate munitions in this area, a pit is dug, and the munitions are placed in the bottom. The pit is then covered with fill, and the munitions are detonated. After detonation, the area is searched manually for unexploded ordnance (UXO). If UXO are encountered, they are redetonated. AEHA identified nine pits where detonation occurred regularly in 1981. Several historic aerial photographs taken intermittently between 1952 and 1981 confirm the locations of nine pits.

2.2.1.6. Previous Investigation Results. Soil sampling and analysis was conducted in four of the nine pits in 1981 during the Phase II AEHA study. However, available reports do not contain figures that indicate pits or sample locations. Six surface soil samples, obtained from each of the four pits (24 total), were analyzed for 2,4,6-trinitrotoluene (2,4,6-TNT), 2,6-dinitrotoluene (2,6-DNT), 2,4-dinitrotoluene (2,4-DNT), and for EP Toxicity analyses of metals and the explosives cyclotetramethylenetetranitramine (HMX), cyclonite (RDX), and tetryl (TETRYL). Leachable concentrations of cadmium (CD) exceeded the RCRA criteria limit of 1.0 mg/L in all four pits. In addition, elevated levels of barium and detectable levels of several explosives were identified in four pits. Analytical results of the Main Demolition Area surface soil sampling program are as follows (AEHA, 1983):

- Cadmium — Detected at EP Toxicity levels in 24 of 24 samples ranging from 0.12 to 2.05 mg/L
- Barium — Detected at EP Toxicity levels in 22 of 24 samples ranging from 1.11 to 2.97 mg/L
- Mercury — Detected at EP Toxicity levels in three of 24 samples ranging from 0.0002 to 0.0003 mg/L
- Arsenic — Not detected by EP Toxicity
- Chromium — Not detected by EP Toxicity
- Lead — Not detected by EP Toxicity
- Silver — Not detected by EP Toxicity
- Selenium — Not detected by EP Toxicity

- HMX Detected at EP Toxicity levels in 18 of 24 samples ranging from 1.0 to 13.0 mg/L

- RDX Detected at EP Toxicity levels in 22 or 24 samples ranging from 2.0 to 149 mg/L

- 2,4,6-TNT Detected in three of 24 samples ranging from 1.2 to 18.8 mg/kg

- 2,6-DNT Detected in one of 24 samples at 1.1 mg/kg

- 2,4-DNT Not detected

- TETRYL Not detected by EP Toxicity

2.2.1.7. Cluster Bomb Detonation Area (SWMU-1a). Very little information is available regarding detonation practices at the Cluster Bomb Detonation Area. Figure 2-3 depicts two possible locations for this SWMU. The location identified by AEHA in 1983 has been compared to aerial photographs, however, the photographs do not show any visible demolition craters in the area. Identification of the second area (Jordan, 1990) is based on the review of available aerial photographs. Field inspections of the second area conducted by JMM revealed numerous shallow craters. Operations at the Cluster Bomb Detonation Area reportedly were conducted for about five or six years (Rutishauser, 1991). According to AEHA (1983), these activities ceased in 1977.

2.2.1.8. Previous Investigation Results. AEHA collected and analyzed four surface soil samples from the Cluster Bomb Detonation Area in 1981, although available documents do not identify the sample locations. The samples were analyzed for 2,4,6-TNT, 2,4-DNT, 2,6-DNT, HMX, RDX, and TETRYL, and EP Toxicity of eight RCRA metals (AS, CD, CR, HG, PB, AG, BA, and SE). Results of the sampling program are as follows (AEHA, 1983):

- Cadmium Not detected by EP Toxicity

- Barium Detected at EP Toxicity levels in 2 of 4 samples ranging from 1.15 to 1.16 mg/L

- Mercury — Detected at EP Toxicity levels in three of four samples ranging from 0.0003 to 0.0004 mg/L

- Arsenic — Detected at EP Toxicity levels in four of four samples ranging from 0.015 to 0.021 mg/L

- Chromium — Not detected by EP Toxicity

- Lead — Detected at EP Toxicity levels in one of four samples at 0.32 mg/L

- Silver — Not detected by EP Toxicity

- Selenium — Not detected by EP Toxicity

- HMX — Not detected by EP Toxicity

- RDX — Detected in one of four samples at 1.3 mg/L

- 2,4,6-TNT — Detected in one of four samples at 2.2 mg/kg

- 2,6-DNT — Not detected

- 2,4-DNT — Not detected

- TETRYL — Detected at EP Toxicity in one of four samples at 1.3 mg/L

2.2.1.9. Propellant Burn Pad (SWMU-1b). The Propellant Burn Pad was a 90- by 300-foot pad cleared of vegetation where propellant was burned in open trenches and projectiles were flashed. Open burning reportedly ceased before 1977 (AEHA, 1983). The location of the Propellant Burn Pad, as identified by AEHA in 1983, is shown in Figure 2-4. This location coincides with a large scar visible on aerial photographs from 1959, 1966, and 1978. Analysis of these aerial photographs indicates that five separate trenches were excavated in the pad. It is likely that the propellants were burned and the projectiles flashed in these trenches. Field observations of this location conducted by JMM in 1991 indicate that this area has been regraded and revegetated.

2.2.1.10. Previous Investigation Results. During Phase II sampling, AEHA collected a total of 14 soil samples from seven locations at the Propellant Burn Pad. Samples were collected from zero to 6 inches and from 6 to 18 inches below the ground surface. The samples were analyzed for 2,4,6-TNT, 2,4-DNT, 2,6-DNT, HMX, RDX, and TETRYL, and EP Toxicity of eight RCRA metals (AS, CD, CR, HG, PB, AG, BA, and SE). Results of the sampling program are presented in Table 2-2.

2.2.1.11. Trash Burn Pits (SWMU-1c). The Trash Burn Pits were used until 1977 for open burning of waste packaging material potentially contaminated with explosives. Pits were dug and filled with materials for burning. When the pit was full of ash and debris, it was covered and graded, and a new pit was excavated. Generally, three pits were in operation at a time. Correspondence from the director of the N TEAD Ammunition Directorate reports that the trenches, dug by excavation equipment, were up to several hundred feet long, 8 to 10 feet wide, and 4 to 6 feet deep (Rutishauser, 1990). Analysis of historic aerial photographs show trenches 50 to 100 feet long in the general locations shown in Figure 2-4 (USEPA, 1982).

2.2.1.12. Various types of waste have reportedly been disposed of in the Trash Burn Pits. Munitions may have been disposed of with trash from propagation testing and solvent drums reportedly were observed in the Trash Burn Pits (AEHA, 1983). During a November 1989 site visit by E.C. Jordan personnel, a biological simulant canister and shrapnel were observed (Jordan, 1990b). Volatile organic compound (VOC) contaminated wastes were also reportedly disposed of in the pits; however, soils have never been analyzed for VOCs. Open detonation of munitions is not believed to have occurred in this area (McCoy, 1989).

2.2.1.13. Previous Investigations. Three samples, including one burn residue sample and two soil samples, were collected from the Trash Burn Pits during the AEHA Phase II sampling. Samples were analyzed for EP Toxicity metals, RDX, HMX, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT. Arsenic, barium, mercury, and 2,4,6-TNT were detected in the soil samples (AEHA, 1983).

TABLE 2-2

PROPELLANT BURN PAD SOIL SAMPLING RESULTS

Parameter	0 to 6 Inches bgs		6 to 18 Inches bgs		Detection Limit
	Number of Samples Above Detection Limit	Range of Concentration	Number of Samples Above Detection Limit	Range of Concentration	
EP toxicity AS (mg/L)	4 of 7	0.011 - 0.016	3 of 7	0.012 - 0.017	0.01
EP Toxicity HG (mg/L)	4 of 7	0.0004 - 0.0006	4 of 7	0.0003 - 0.0006	0.0002
EP Toxicity HMX (mg/L)	3 of 7	1.0 - 4.0	1 of 7	7.5	Not Identified
EP Toxicity RDX (mg/L)	2 of 7	2.5, 17.3	2 of 7	1.1, 1.7	Not Identified
246TNT (mg/kg)	2 of 7	2.6 - 52	1 of 7	10.4	1.0
24DNT (mg/kg)	1 of 7	1.1	Zero	ND	1.0
25DNT (mg/kg)	Zero	ND	1 of 7	1.2	1.0

Parameters analyzed for, but not detected are: EP Toxicity BA, CD, CR, PB, SE, AG, and TETRYL.

Misc. Acronyms:

EP - Extraction Procedure
BGS - Below Ground Surface
mg/L - milligram per liter
mg/kg - milligrams per kilogram
ND - Not detected

USATHAMA Chemical Codes:

AG - Silver
AS - Arsenic
BA - Barium
CD - Cadmium
CR - Chromium
HG - Mercury
HMX - cyclotetramethylene-tetranitramine
PB - Lead
ROX - Cyclonite
SE - Selenium
TETRYL - Teltryl
246TNT - 2.4.6-trinitrotoluene
24DNT - 2.4-dinitrotoluene
26DNT - 2.6-dinitrotoluene

Source: AEHA (1983)

2.2.1.14. During Phase IV of the AEHA study, 35 soil samples were collected, including eight from surface soil sample locations and 29 from boreholes in the Trash Burn Pits area. Samples from the boreholes were collected at depths ranging from 5 feet to 20 feet bgs. Phase IV samples were analyzed for EP Toxicity metals, total metals (PB, CR, CD, AS, AG, BA, HG, and SE), and explosives (HMX, RDX, 246-TNT, TETRYL, 24-DNT, and 26-DNT). All EP Toxicity results were below the detection limits. RDX was found in four of the surface soil samples (2.2 mg/kg to 14.9 mg/kg) and HMX was found in one surface soil sample (2.4 mg/kg). These results did not exceed the explosive compound guidelines (1,000 mg/kg) established for the AEHA study. Other compounds that were detected included several metals (AS, PB, CR, CD, and BA). However, arsenic, lead, and chromium were believed to be naturally occurring in the soils. Results of this investigation suggest that the primary chemicals of concern at this site are barium, lead, and cadmium. The metals, HMX, and RDX results for the soil samples collected during this study are presented in Table 2-3.

2.2.1.15. **Propellant Burn Pans (SWMU-1d).** In recent years, all propellants have been burned according to AEHA recommended best management practices (AEHA, 1987). These practices include use of containment devices such as steel burn pans which are covered to prevent precipitation from accumulating between burns. After a burn is completed, all ash and residue are containerized and handled as a hazardous waste. Eight burn pans are currently located in the southwest portion of SWMU-1 as depicted in Figure 2-3.

2.2.1.16. **Groundwater Analytical Data From OB/OD Areas.** Groundwater data for the OB/OD Areas are limited to a sample from N TEAD water supply well WW-4 (see Figure 3-5). This sample was analyzed in 1987 for polychlorinated biphenyls (PCBs), pesticides, VOCs, semi-volatile organic compounds (SVOCs), explosives, metals, nitrate/nitrite, and sulfate (EA, 1988). Analytical results indicated that both wells were not contaminated with organic compounds (none were detected). Nitrate was the only inorganic compound detected above background levels and exceeded the maximum contaminant level of 10 mg/L.

TABLE 2-3

TRASH BURN PITS SOIL SAMPLING RESULTS

	9H1			9H2					
(Depth bgs ft)	(0)	(2-3)	(4-5)	(0)	(1-2)	(4-5)	(5-9)	(14-15)	(18-19)
Parameter									
AS	0.25	0.25	0.30	BDL	BDL	BDL	BDL	BDL	0.51
BA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CD	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CR	2.47	2.41	2.28	1.75	0.55	BDL-	0.70	0.16	0.50
PB	0.45	0.30	0.48	3.27	0.40	BDL	0.65	BDL	0.56
HMX	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
RDX	BDL	BDL	BDL	5.4	BDL	BDL	BDL	BDL	BDL

Borehole Number	9H3					9H4			
(Depth bgs) (ft)	(0)	(4-5)	(9-10)	(14-15)	(18-20)	(0)	(4-5)	(8-9)	(14-15)
Parameter									
AS	BDL	0.49	BDL	0.86	NA	BDL	BDL	0.52	BDL
BA	30.7	16.6	BDL	BDL	NA	BDL	BDL	BDL	16.6
CD	0.06	BDL	BDL	BDL	NA	BDL	BDL	0.05	BDL
CR	0.56	0.51	BDL	1.00	NA	0.88	BDL	0.76	BDL
PB	36.3	7.57	BDL	1.19	NA	3.89	BDL	1.38	BDL
HMX	BDL	BDL	BDL	BDL	NA	BDL	BDL	BDL	BDL
RDX	BDL	BDL	BDL	BDL	NA	BDL	BDL	BDL	BDL

Borehole Number	9H5				9H6			9H7		
(Depth bgs) (ft)	(0)	(4-5)	(5-9)	(14-15)	(0)	(4-5)	(9-10)	(0)	(4-5)	(5.5-6)
Parameter										
AS	BDL	0.52	0.67	NA	0.38	0.51	0.56	0.42	0.50	0.47
BA	BDL	BDL	BDL	NA	16.9	BDL	BDL	BDL	BDL	BDL
CD	BDL	BDL	BDL	NA	BDL	0.08	BDL	BDL	BDL	BDL
CR	1.12	0.97	0.72	NA	0.84	0.95	0.71	0.81	0.82	0.97
PB	2.30	1.71	1.19	NA	1.91	2.34	1.00	1.96	1.03	1.30
HMX	BDL	BDL	BDL	NA	BDL	BDL	BDL	BDL	BDL	BDL
RDX	BDL	BDL	BDL	NA	BDL	BDL	BDL	BDL	BDL	BDL

TABLE 2-3

TRASH BURN PITS SOIL SAMPLING RESULTS
(CONTINUED)

Surface Soil	Canyon Drainage			Canyon Head		Burn Area Drainway		Mouth
Parameter								
AS	0.33	BDL	0.35	BDL	0.30	0.51	0.26	0.67
BA	BDL	BDL	BDL	BDL	BDL	BDL	BDL	21.6
CD	0.06	BDL	0.10	0.65	0.30	BDL	0.26	0.06
CR	0.54	0.53	0.70	1.18	0.80	0.98	0.54	1.48
PB	1.95	0.96	4.47	2.33	4.67	1.92	1.67	3.08
HMX	2.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL
RDX	14.9	2.2	3.4	BDL	0.65	BDL	BDL	BDL

Parameters analyzed for, but not detected are: TETRYL, 246TNT, 24DNT, 26DNT, AG, HG, SE, and EP Toxicity of AG, AS, BA, CD, CR, HG, PS, SE.

All results are in mg/kg.

Misc. Acronyms:

BDL - Below Detection Limit
bgs - Below Ground Surface
EP - Extraction Procedure Toxicity Test
ft - feet
mg/kg - milligrams per kilogram
NR - No Recovery
HG - Mercury

USATHAMA Chemical Codes:

AG - Silver
AS - Arsenic
BA - Barium
CD - Cadimum
CR - Chromium
26DNT - 2,6-dinitrotoluene
246 DNT - 2,4,6-trinitrotoluene
HMX - Cyclotetramethylene-tetranitramine
PB - Lead
RDX - Cyclonite
SE - Selenium
TETRYL - Tetryl
24DNT - 2,4- dinitrotoluene

Source: AEHA (1983)

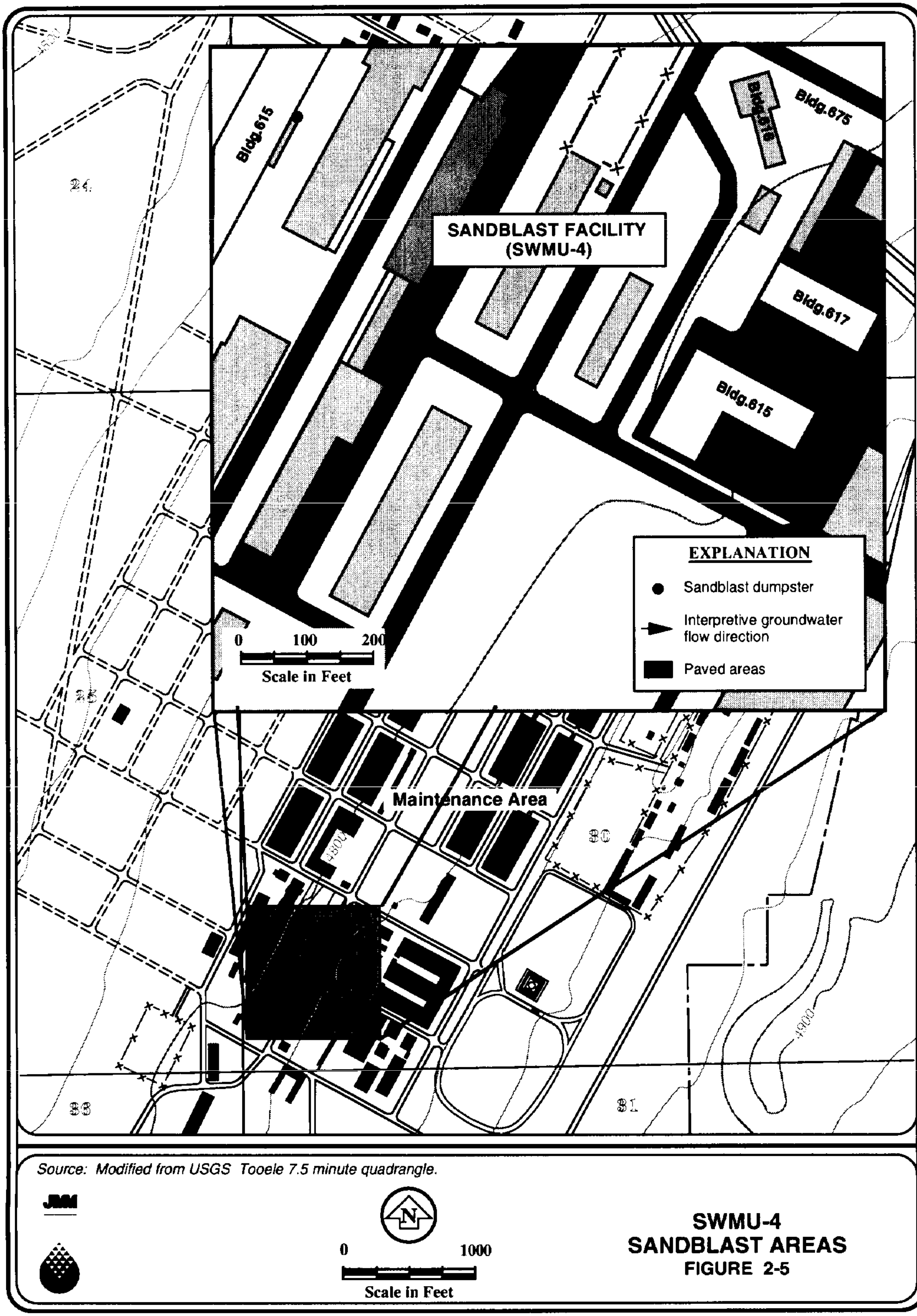
2.2.2. Sandblast Area (SWMU-4)

2.2.2.1. Three Sandblast Areas are present in the Maintenance Area of N TEAD. They are located in Buildings 615, 617, and 597 as depicted in Figure 2-5. Vehicular maintenance including sandblasting, painting, and stripping operations are conducted at these facilities. Wastes produced include used sandblast media and paint stripping solutions. Three types of sandblast media (i.e., steel grit, ground walnut shells, and glass beads) are used. These media are reused until they lose their effectiveness. The spent material has a consistency of fine dust, and it is collected in sealed hoppers for temporary storage prior to removal and off-site disposal by a hazardous waste contractor. Paint stripping solutions include phosphoric acid, hydrochloric acid, and sodium peroxide. Waste products are also produced in the paint booths. The stripping wastes, paint booth wastes, and spent solvents from degreasing operations are drummed and then removed for off-site disposal by a hazardous waste contractor.

2.2.2.2. Analysis of used sandblast media samples collected by N TEAD Environmental Management Office (EMO) personnel found that the spent steel dust contained measurable concentrations of barium, cadmium, lead, and nickel, but not above the EP Toxicity maximum concentrations specified by EPA for characterizing a waste as hazardous (Rasmussen, 1991). The spent walnut dust also contained barium, cadmium, chromium, and lead. Total lead and chromium concentrations were 17,000 mg/kg (1.7 percent) and 3,000 mg/kg (0.3 percent), respectively. EP Toxicity levels for chromium were exceeded (greater than 5.0 mg/L). No analytical results of the spent glass beads were available.

2.2.2.3. Physical Setting. All three of the sandblast areas are located inside buildings where the sandblast media is recycled. The spent media is diverted into hoppers that empty into sealed dumpsters outside the buildings. Since the dumpsters are placed on concrete slabs which are surrounded by asphalt parking and roadways, there is little or no exposed soil in the immediate vicinity of these dumpsters. Gravelly soils are expected to be present beneath the paved areas. The depth to groundwater is expected to be about 280 feet below ground and the flow is toward the northwest.

2.2.2.4. Previous Investigations. Other than the analyses of the spent media described above, no previous investigations have been conducted at the sites, although there is a potential for soil contamination in this area because of the type of industrial processes that



SWMU-4
SANDBLAST AREAS
FIGURE 2-5

PROJECT NO. 2942.0120

are performed at this SWMU. The primary contaminants expected to be present in materials used at this site are metals, VOCs, and SVOCs.

2.2.3. Sewage Lagoons (SWMU-14)

2.2.3.1. Site Description. Two Sewage Lagoons are located on the west side of the maintenance area of N TEAD approximately 2,000 feet northwest and downgradient of the sanitary landfill. The location of SWMU-14 is depicted in Figure 2-6.

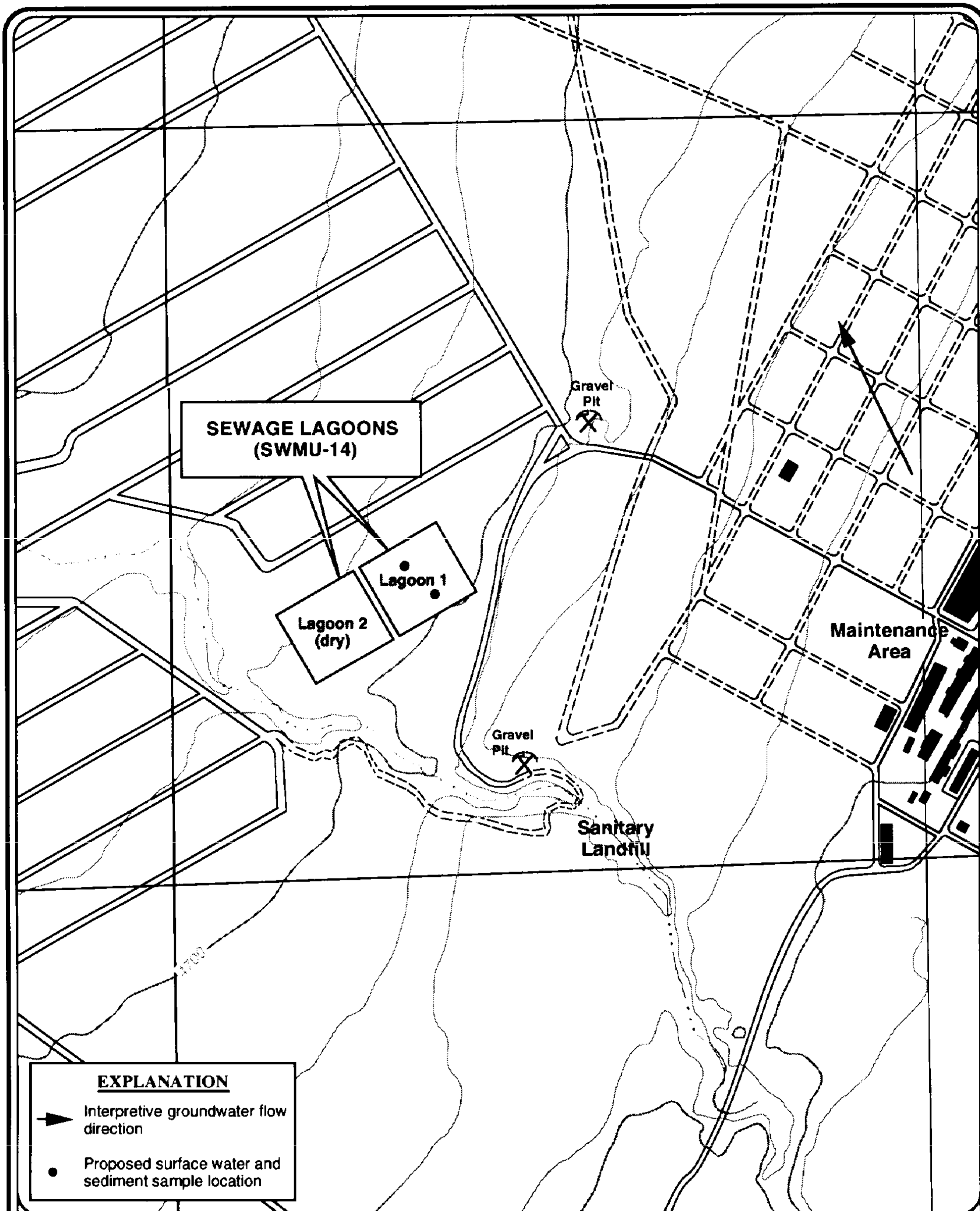
2.2.3.2. Discharge of domestic wastewater from housing and warehouses in the maintenance and administrative areas to the sewage lagoons began in 1974. Each lagoon covers approximately 7.4 acres (617 feet by 518 feet) and is four feet deep (EA, 1988). The capacity of each lagoon is approximately 9 million gallons. The average daily flow rate to the lagoons is approximately 90,000 gallons per day (ERTEC, 1982).

2.2.3.3. The lagoons were designed so that the first lagoon initially fills with wastewater. Discharge to the second lagoon20

occurs only when the first is completely filled. Under normal operating conditions and when evaporation rates are high (summer, spring, and fall), only the first lagoon remains filled. Generally, the second lagoon receives discharge from the first only during the winter months. During E.C. Jordan's 1989 site visit, Tooele personnel indicated that although the lagoon bottoms and lower portions of the perimeter berms were lined with native clay, the liner probably leaked (Fox, 1989). In addition, the wastewater in the first lagoon often rises above the clay liner, allowing wastewater to discharge into the unlined portions of the perimeter berms. It has been estimated that 60 to 70 percent of the effluent has percolated into the underlying soils (JMM, 1988).

2.2.3.4. Physical Setting. Previous investigations in the IWL area indicated that soils in this area consist of coarse-grained sands and gravels interlayered with fine-grained silts and clays (JMM, 1988). The depth to bedrock in the lagoon area is estimated at 1,125 feet bgs (ERTEC, 1982). The regional groundwater is estimated to be 200 feet bgs, and the direction of groundwater flow is toward the northwest (JMM, 1987).

2.2.3.5. Previous Investigations. To date, the impact of the Sewage Lagoons on groundwater quality has not been characterized. Previous investigations, (JMM, 1988;



Source: Modified from USGS Tooele 7.5 minute quadrangle and TEAD general site map.

JMM

SWMU-14
SEWAGE LAGOONS
FIGURE 2-6

PROJECT NO. 2942.0120

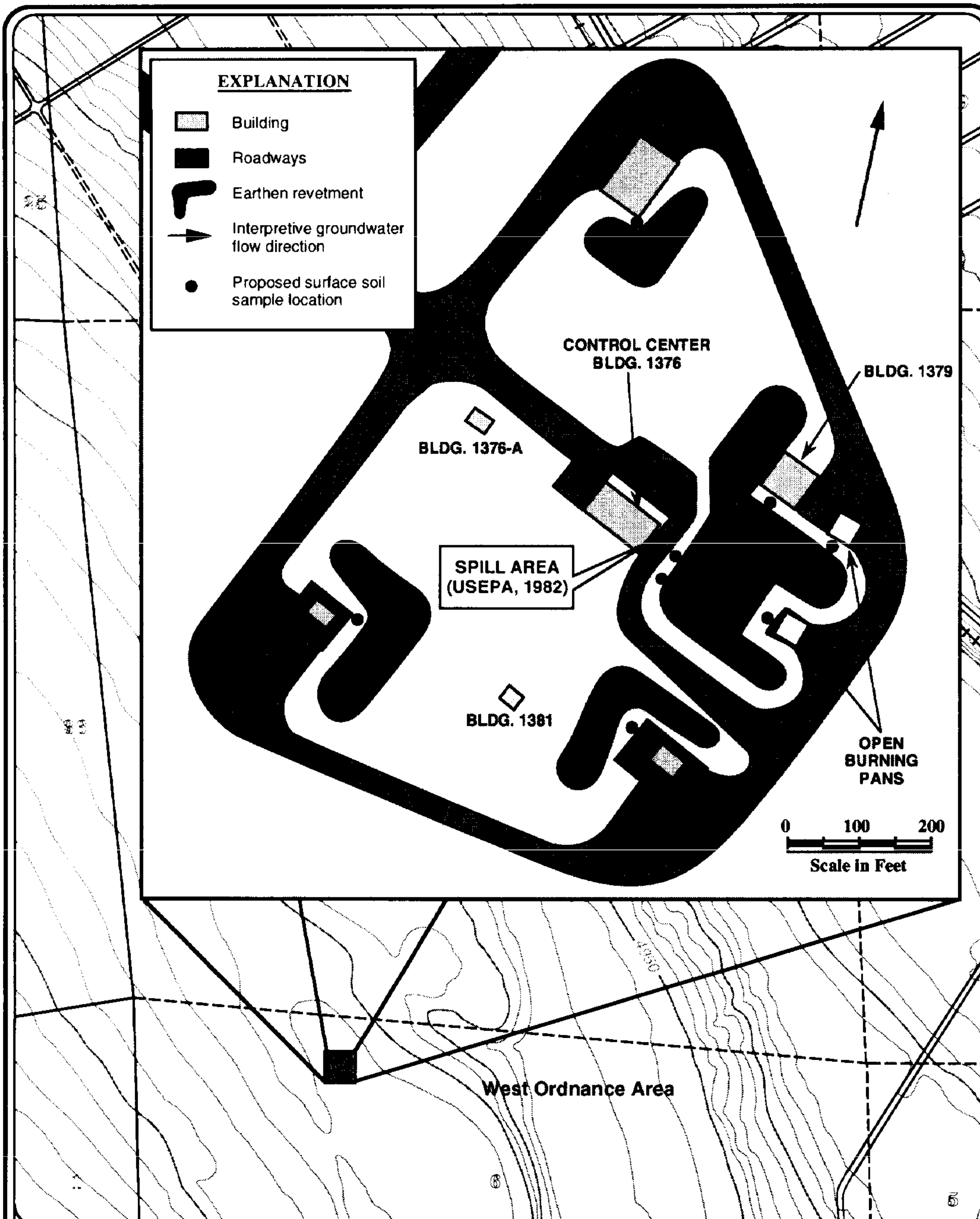
Weston, 1990; and ERTEC, 1982) have indicated the presence of metals, VOCs, and several metals in monitoring wells both upgradient and downgradient of the sewage lagoons. Monitoring wells immediately upgradient of the sewage lagoons are downgradient of the Sanitary Landfill (SWMUs-12 and -15) and cross gradient from the closed industrial waste lagoon outfall ditches, both of which have been sources of groundwater contamination. A groundwater sample collected by ERTEC (1982) from monitoring well N-4, approximately 1,200 feet downgradient of the lagoons, had elevated concentrations of nitrate, nitrite, nickel, zinc, chloride, fluoride, sulfate, and sodium, in addition to detectable levels of trichloroethylene and gross beta radiation. Trichloroethylene was also found in the groundwater immediately downgradient of Lagoon 1 in monitoring well B-1 at a concentration of 13 μg/L (JMM, 1988). Trichloroethylene was also detected in other monitoring wells both upgradient (N-119-88, at 18.4 μg/L; and A-2, at 3.9 μg/L) and downgradient (B-4, at 22 μg/L; and N-4, at 1.2 μg/L) of the lagoons. Other VOCs, including 1,1,1-trichloroethane, xylene, benzene, trans-1,2-dichloroethene were detected in monitoring wells upgradient of the lagoons, but not in monitoring wells downgradient of the lagoons. Based on the available data, the impact of the Sewage Lagoons on groundwater quality cannot be interpreted.

2.2.3.6. The available data indicate the primary chemicals of concern at the Sewage Lagoon site are most likely VOCs and metals. However, because the lagoons have been in operation for 17 years and because of the numerous sources of wastewater there is a possibility other chemicals may also be present at this site.

2.2.4. AED Demilitarization Test Facility (SWMU-19)

2.2.4.1. Site Description. The Ammunition Engineering Directorate (AED) Demilitarization Test Facility is located southwest of the Ordnance Area at the southern end of the road that links the AED Deactivation Furnace Site (SWMU-20) and the Bomb and Shell Reconditioning Building (SWMU-23). The facility was constructed in 1973 and is composed of several small buildings and sheds, and a series of protective revetments where tests are conducted. The AED Demilitarization Test Facility is depicted in Figure 2-7.

2.2.4.2. Operations conducted at the facility include experimental or pilot plant type tests intended to determine if new-design demilitarization equipment is functional and to



Source: Modified from USGS Tooele 7.5 minute quadrangle.

0 1000
Scale in Feet

SWMU-19
AED DEMILITARIZATION TEST FACILITY
FIGURE 2-7

PROJECT NO. 2942.0120

develop procedures, techniques, or additional equipment to implement the new-design equipment (EA, 1988). Live ammunition and propellants are frequently used during the testing. In addition to demilitarization equipment tests, propagation tests (e.g., blasting one rocket in a pallet of rockets to see if the detonation propagates), barricade testing for explosive lines, and open burning in burning pans (intended to optimize the design of the pans) are conducted here (Jordan, 1989a). The facility is used only intermittently approximately 30 days per year (EA, 1988).

2.2.4.3. Based on telephone interviews conducted by JMM (Zaugg, 1991) activities conducted in each of the buildings at this facility are described as follows:

- Building 1376 serves as a control center for the facility. It contains a test preparation bay and protected observation areas where munitions casings are sawed or sheared apart. Wash water in this building is collected in a sealed sump for treatment at one of the deactivation furnaces.

- Building 1376-A contains a boiler plant for the facility.

- Building 1377 contains a large reciprocating saw used to cut apart bombs and projectiles.

- Building 1378 was used to test methods of removing pyrotechnics from projectiles by chemical dissolution and by microwave eradication.

- Building 1379 simulates a standard munition handling bay and is used to test protective shields and barricades.

- Building 1380 is actually a concrete slab which is used for equipment storage. N TEAD security requires that there is no overnight storage of explosives at this facility.

2.2.4.4. In addition to the buildings, there is an open area south of the facility where open detonation blast propagation testing has been conducted. Only small scale propagation tests of M-61 rockets (M-55 rocket simulants) have been performed at this location. Large scale propagation tests are conducted at the Main Demolition Area (SWMU-1). Upon completion of detonation-type work, a manual surface sweep of the surrounding area is performed to ensure that no explosive residuals remain (Jordan, 1989a). The sweep is conducted within a 1,400-foot radius from the detonation point. Recovered materials are taken to the Trash Burn Pits (SWMU-1c) or the Deactivation Furnace Building 1320 (SWMU-21) for disposal (EA, 1988).

2.2.4.5. During a site visit by JMM in January, 1990, two burning trays were located in the eastern portion of the site (Figure 2-7). Reportedly, the trays are used infrequently, and any waste that is produced is contained within the trays (JMM, 1990). There is no spill containment under or around the trays.

2.2.4.6. An Environmental Photographic Interpretation Center (EPIC) aerial photograph in 1981 shows a liquid spill that appears to have originated from Building 1376 (USEPA, 1982). Liquid apparently flowed out the doors on the southeast side of the building and then, after flowing downhill a short distance, percolated into soils at the toe of a revetment immediately across the road from the building. The source and composition of the liquid spill are unknown.

2.2.4.7. Physical Setting. The surface soil at the AED Demilitarization Test Facility appears to consist mostly of sand (JMM, 1990). The approximate depth to the water table is 630 feet bgs, and the direction of groundwater flow is toward the north/northeast (JMM, 1987). The approximate depth to bedrock is 250 feet bgs (ERTEC, 1982).

2.2.4.8. Previous Investigations. No previous investigations have been conducted at the AED Demilitarization Test Facility, and no analytical data are available for this site. The primary chemicals expected to have been present in materials used at this site are metals and explosives. Semi-volatile organic compounds also are likely in the burn residues.

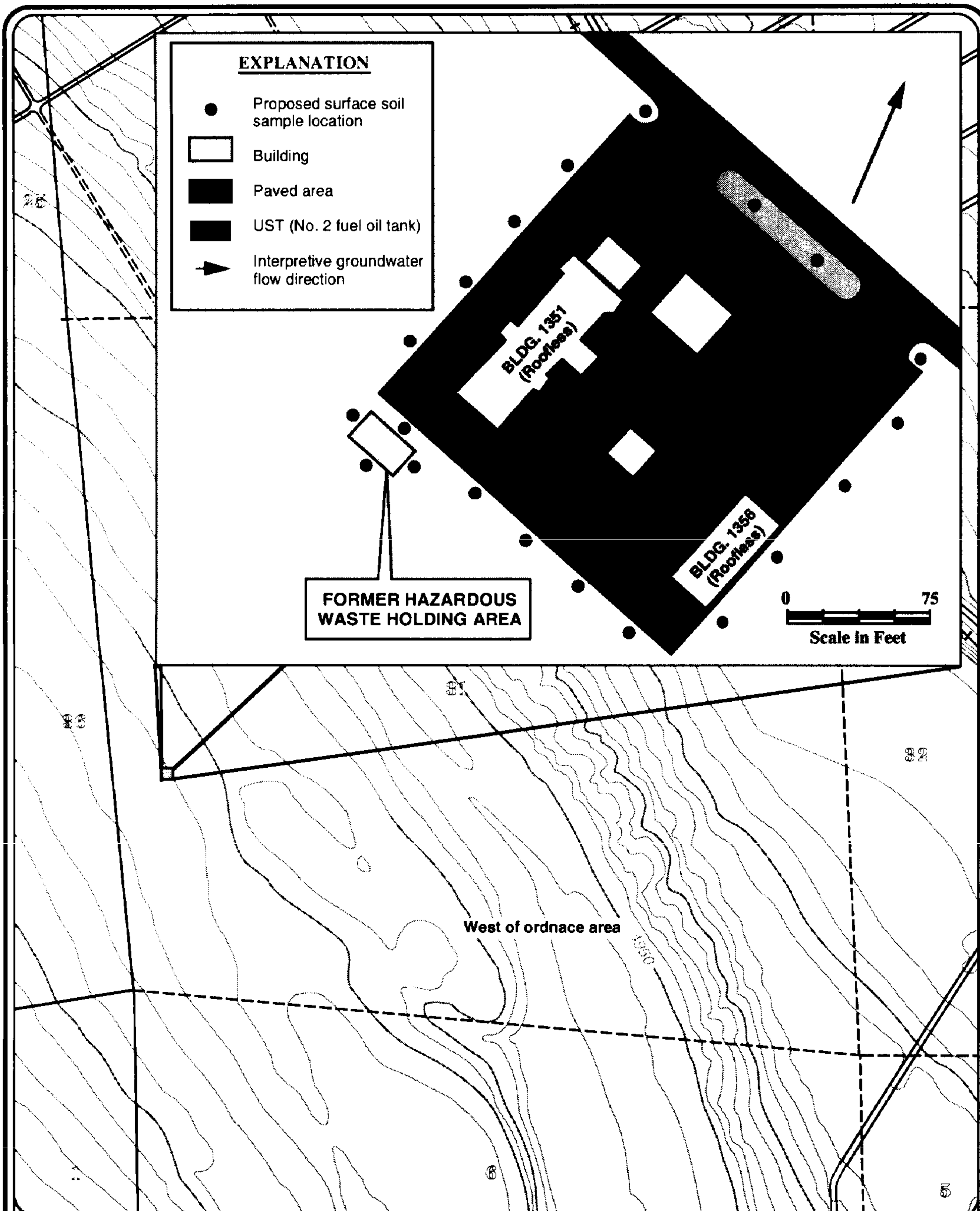
2.2.5. AED Deactivation Furnace Site (SWMU-20)

2.2.5.1. Site Description. The AED Deactivation Furnace Site is located southwest of the Ordnance Area, along the road that links the AED Demilitarization Facility (SWMU-19) and the Bomb and Shell Reconditioning Building (SWMU-23). This site is used to test demilitarization procedures for various munitions and it is not normally used as a production facility (Ray, 1990). The location of the AED Deactivation Furnace Site is depicted in Figure 2-8.

2.2.5.2. The facility is composed of three roofless structures (Buildings 1351, 1352, and 1356) that were installed in approximately 1970 and upgraded in 1976. The deactivation furnace in Building 1352 is a rotary kiln that has been used for the destruction of high explosive-filled projectiles (up to 155 mm), grenades, propellants, boosters, fuses, white phosphorous rockets, and bulk explosives (EA, 1988). The flashing furnace in Building 1356 was added to the AED Deactivation Furnace Site in 1976 (Ray, 1990). The flashing furnace is used for burning residuals remaining in munition shell casings after initial treatment in the deactivation furnace. This furnace is reportedly capable of a destruction and removal efficiency of 99.999 percent (McCoy, 1989). During the upgrade in 1976, a shared air pollution control system was installed to treat stack emissions from both the deactivation furnace and the flashing furnace (Ray, 1990). The air pollution control equipment includes an afterburner, cyclone, gas cooler, baghouse, and wet scrubber. Depending upon the operating parameters of a particular test, the air pollution control system design allows for the selective use of air pollution control equipment. The deactivation furnace and flashing furnace are fired by No. 2 fuel oil (Bishop, 1990). Fuel oil is stored in an underground storage tank (UST) located near the center of the facility (see Figure 2-8).

2.2.5.3. After deactivation, all residual metal parts are certified as clean and are sent to the Defense Reutilization and Marketing Office (DRMO) for salvage (EA, 1988). At the time of a recent site visit, no materials were staged at the facility, although a hazardous waste collection point is present where incinerator ash and cyclone/baghouse dust are drummed as a hazardous waste. The drums are sealed and sent to the 90-day storage yard (SWMU-28) pending analysis and disposal. In 1988, this SWMU received a permit to experiment with the incineration of hazardous wastes including paint sludge and sandblast waste from painting production lines.

2.2.5.4. **Physical Setting.** The soil surrounding the AED Deactivation Furnace is composed of sands and gravelly sands. The ground around the furnace buildings and associated support facilities is paved (Jordan, 1989a). The approximate depth to groundwater is 620 feet below ground surface and the direction of groundwater flow is toward the northeast (JMM, 1987).



Source: Modified from USGS Tooele 7.5 minute quadrangle.

JMM

0 1000
Scale in Feet

SWMU-20
AED DEACTIVATION FURNACE SITE
FIGURE 2-8

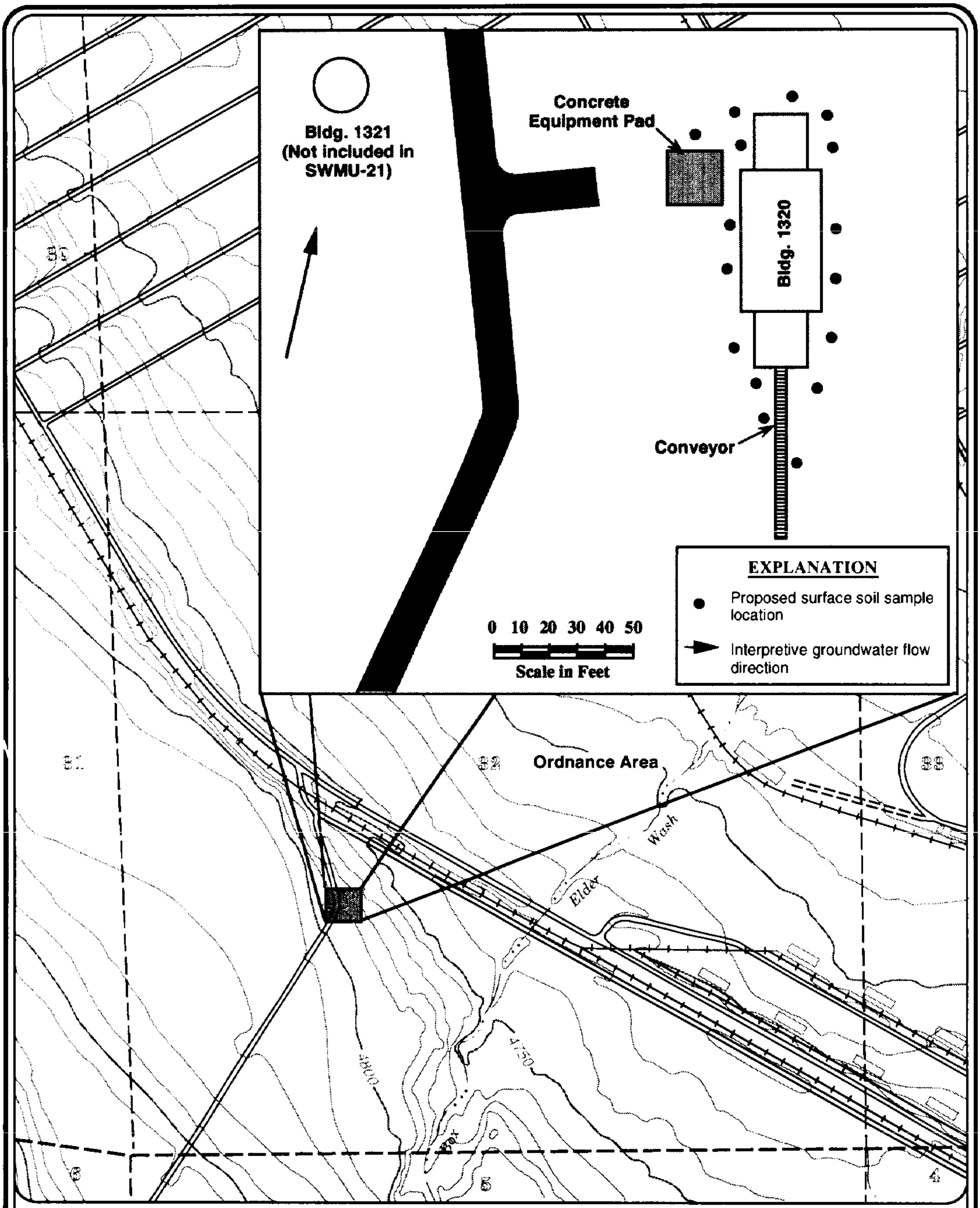
PROJECT NO. 2942.0120

2.2.5.5. Previous Investigations. Because the furnaces are used to experiment with a variety of feedstocks, the composition of furnace ash and cyclone/baghouse dust is variable. Although baghouse dust was determined not to be a reactive hazardous waste, lead, barium, and cadmium have been detected at concentrations that exceed the maximum concentration specified by the USEPA in 40 CFR 261.24 for characterizing a waste as hazardous based on EP Toxicity limits (AEHA, 1985). EP Toxicity concentrations of cadmium (206 mg/L) were detected in baghouse dust after conducting an incineration test of 20 mm cartridges. Concentrations of lead in baghouse dust, sampled after performing incineration tests of 7.62 mm cartridges and 30 caliber cartridges, resulted in EP Toxicity concentrations of 5,265 µg/L and 4,670 µg/L lead, respectively (AEHA, 1985). Furnace residue collected from building 1351 in July of 1990 contained cadmium and lead concentrations in excess of Toxicity Characteristic Leaching Potential (TCLP) limits (9.8 mg/L cadmium and 220 mg/L lead). The presence of cadmium and lead in excess of TCLP limits, along with presence of 440 ppm total thallium, resulted in a hazardous waste classification for the furnace residue.

2.2.5.6. Stack emission data collected during the same incineration tests indicate that particulate concentrations were less than 0.08 grains/ft^3, which is within the RCRA limit for incinerators. Incineration of bulk explosives during associated tests resulted in particulate emissions sometimes slightly over the RCRA limit.

2.2.6. Deactivation Furnace Building 1320 (SWMU-21)

2.2.6.1. Site Description. The Deactivation Furnace Building 1320 is located in the southwestern portion of N TEAD, near the southwestern perimeter of the Igloo Storage Area as shown in Figure 2-9. This site is an ammunition demilitarization production facility constructed in about 1955. The facility consists of Building 1320 which contains a rotary kiln and an open staging area. The kiln, which is fed by an auger-type screw, was installed in approximately 1955 (NUS, 1987). The staging area is asphalt covered. The residue collection point consists of a single 55-gallon drum located on a concrete pad (unbermed). This area has only been used for the past six to eight months. The facility is used for deactivating small arms ammunition (up to 20 mm), primers, and fuses (Ray, 1990). Air pollution control equipment including a cyclone, gas cooler, and baghouse, was installed in approximately 1975 to treat stack emissions from the furnace (Ray, 1990). The



Source: Modified from USGS Grantsville 7.5 minute quadrangles.

JMM

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Scale in Feet

SWMU-21
DEACTIVATION FURNACE BUILDING
FIGURE 2-9

PROJECT NO. 2942.0120

diagram in Figure 2-9 depicts the site layout of this SWMU. This furnace is a prototype for the deactivation furnace at the AED Deactivation Furnace Site (SWMU-20).

2.2.6.2. Similar to SWMU-20, after deactivation, all remaining metal parts are certified as clean and are sent to the DRMO for salvage (EA, 1988). Incinerator ash and cyclone/baghouse dust are drummed as a hazardous waste and sent to the 90-day drum storage yard (SWMU-28), pending analysis and disposal (McCoy, 1989).

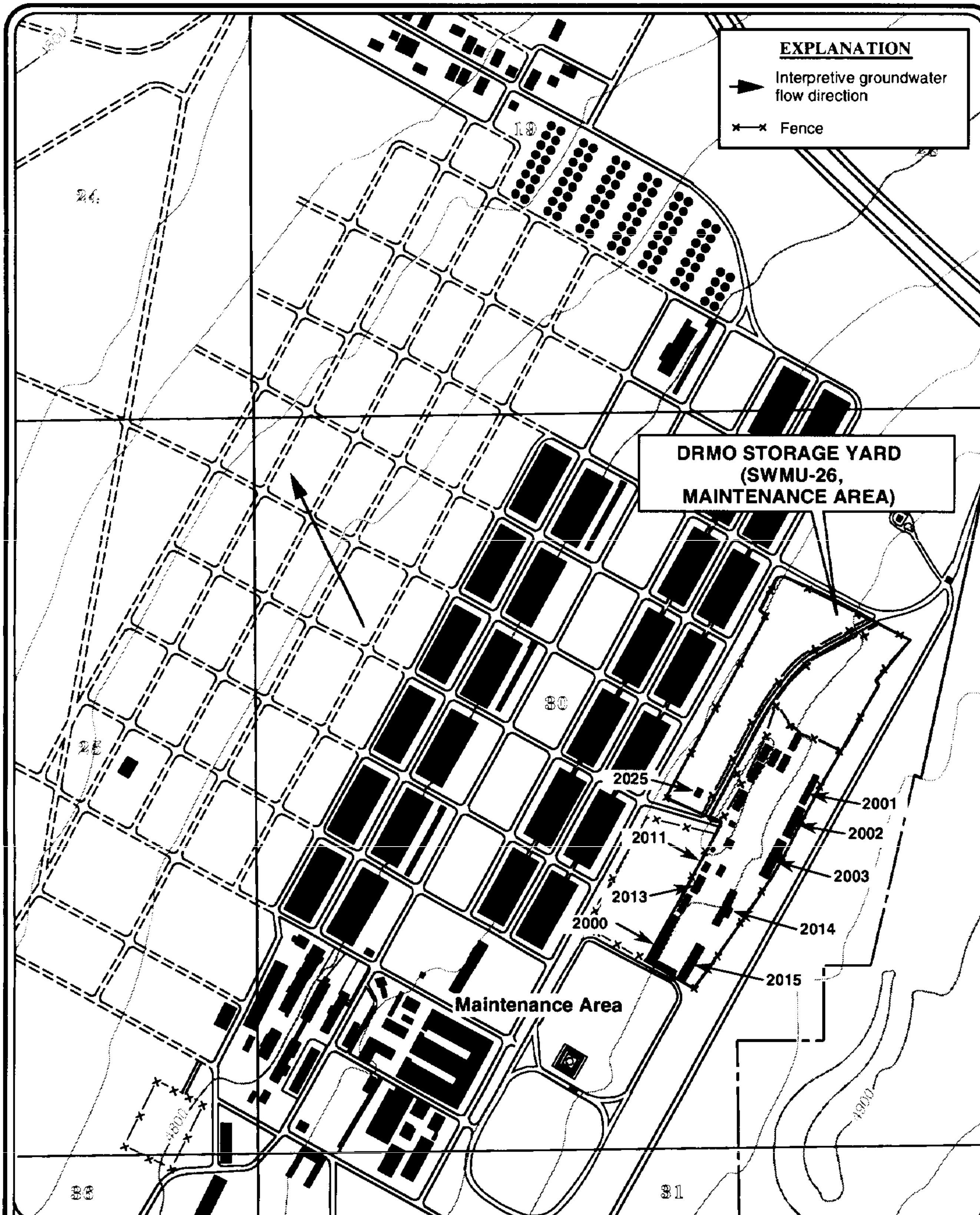
2.2.6.3. Physical Setting. The soil surrounding the Deactivation Furnace Building 1320 is composed of sands or gravelly sands. The ground surface surrounding Building 1320 and under the staging areas is paved (Jordan, 1989a). The approximate depth to the groundwater table is 320 feet bgs, and the direction of groundwater flow is toward the north/northeast (JMM, 1987). The depth to bedrock is approximately 500 feet bgs (ERTEC, 1982).

2.2.6.4. Previous Investigations. A dust sample from the floor under the conveyor contained detectable concentrations of lead, barium, and cadmium, but all were below EP Toxicity limits (Bishop, 1990). However, a sample of baghouse dust collected in January, 1991, exceeded the TCLP concentrations for lead and cadmium characterizing a waste as hazardous which are 5.0 and 1.0 mg/L, respectively. This sample contained levels of cadmium at 60 mg/L and lead at 69 mg/L. The sample also contained elevated levels of cresols and total metals including barium, cadmium, lead, chromium, and nickel (Rasmussen, 1991).

2.2.7. DRMO Storage Yard (SWMU-26)

2.2.7.1. Site Description. The Defense Reutilization and Marketing Office (DRMO) Storage Yard is a 60-acre salvage yard located in the eastern section of the maintenance area. As depicted in Figure 2-10, the site is flat and unpaved with fencing around the perimeter. Several corrugated steel storage buildings occupy portions of the site. This SWMU is used for the temporary storage of surplus material and wastes. Storage times vary according to waste types and range from a few months to several years (NUS, 1987).

2.2.7.2. The DRMO (previously known as the Defense Property Disposal Office (DPDO)) primarily coordinates the sale, recycling, and disposal of N TEAD refuse, and it handles



Source: Modified from USGS Tooele 7.5 minute quadrangle.

JMM

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0 1000

Scale in Feet

SWMU-26
DRMO STORAGE YARD
FIGURE 2-10

PROJECT NO. 2942.0120

the contractual aspects of hazardous waste disposal for TEAD. Although not a major function, small quantities of hazardous materials, in addition to non-hazardous materials, are temporarily stored at the DRMO.

2.2.7.3. According to EPIC aerial photographs, this site became an active storage area sometime between 1953 and 1959 (USEPA, 1982). EPIC's interpretation of a 1959 photograph describes the site as a storage yard, with noticeable ground staining, debris piles, and container storage. In 1966, the site had been graded, and drum storage and ground staining were observed. In a 1981 photograph, large areas of ground staining, as well as drum storage and debris piles, were noted (USEPA, 1982). A site inspection conducted in 1987 reported three ruptured drums (NUS, 1987).

2.2.7.4. Based on observations made during the Jordan site visit in 1989 (Jordan, 1990a) and interviews conducted with DRMO personnel (Brems and Kinsinger, 1989), the following information was obtained regarding the DRMO buildings and stored materials.

2.2.7.5. Flammable Storage Building 2025. Containers of paint, gun solvent, photo-developing solutions, drain cleaner, 1,1,1-trichloroethane, carbon tetrachloride, and other solvents were observed stored on wooden pallets in this building. The building floor is concrete and does not have floor drains, berms, or dikes. No evidence of leaks or spills were noted during the Fall 1989 site visit conducted by Jordan. Stored materials are off-specification products, surplus items, or unusable products designated as hazardous, and they are stored in this building until N TEAD can sell them or move them off the depot.

2.2.7.6. Battery Storage Yard. Approximately 1,000 lead-acid batteries were observed stacked on a concrete pad in a small area in the southeast corner of the yard (Jordan, 1989a). According to N TEAD personnel, the batteries are usually drained of acid prior to acceptance at the DRMO. There were no signs of battery leakage during the Jordan 1989 site visit.

2.2.7.7. Scrap Metal Yard. Metal residues from the Building 1320 Deactivation Furnace (SWMU-21) are stored in open drums on pallets along the eastern boundary of the DRMO yard. In addition, drums of reclaimable electrical equipment parts are also stored here. Brass, lead, copper, and silver are the primary components of the stored drum waste. No stained soil or spilled metal debris was noted by Jordan during their 1989 site visit.

2.2.7.8. Empty Drum Storage. Approximately 300 empty drums were stacked on pallets awaiting removal by a contractor to an off-site location (Jordan, 1989a).

2.2.7.9. Four Small Sheds. Oxidizers (e.g., potassium permanganate), corrosives, and small amounts of acids were stored in four small sheds at the DRMO (Jordan 1989a).

2.2.7.10. Waste Oil. Jordan personnel noted that approximately 60 drums of waste oil were stacked in one section of the DRMO yard. They also found some small oil-stained areas near the drums (Jordan, 1989a). These waste oils are from the vehicle maintenance operations conducted on the depot. Transformer oils are not handled at the DRMO Storage Yard.

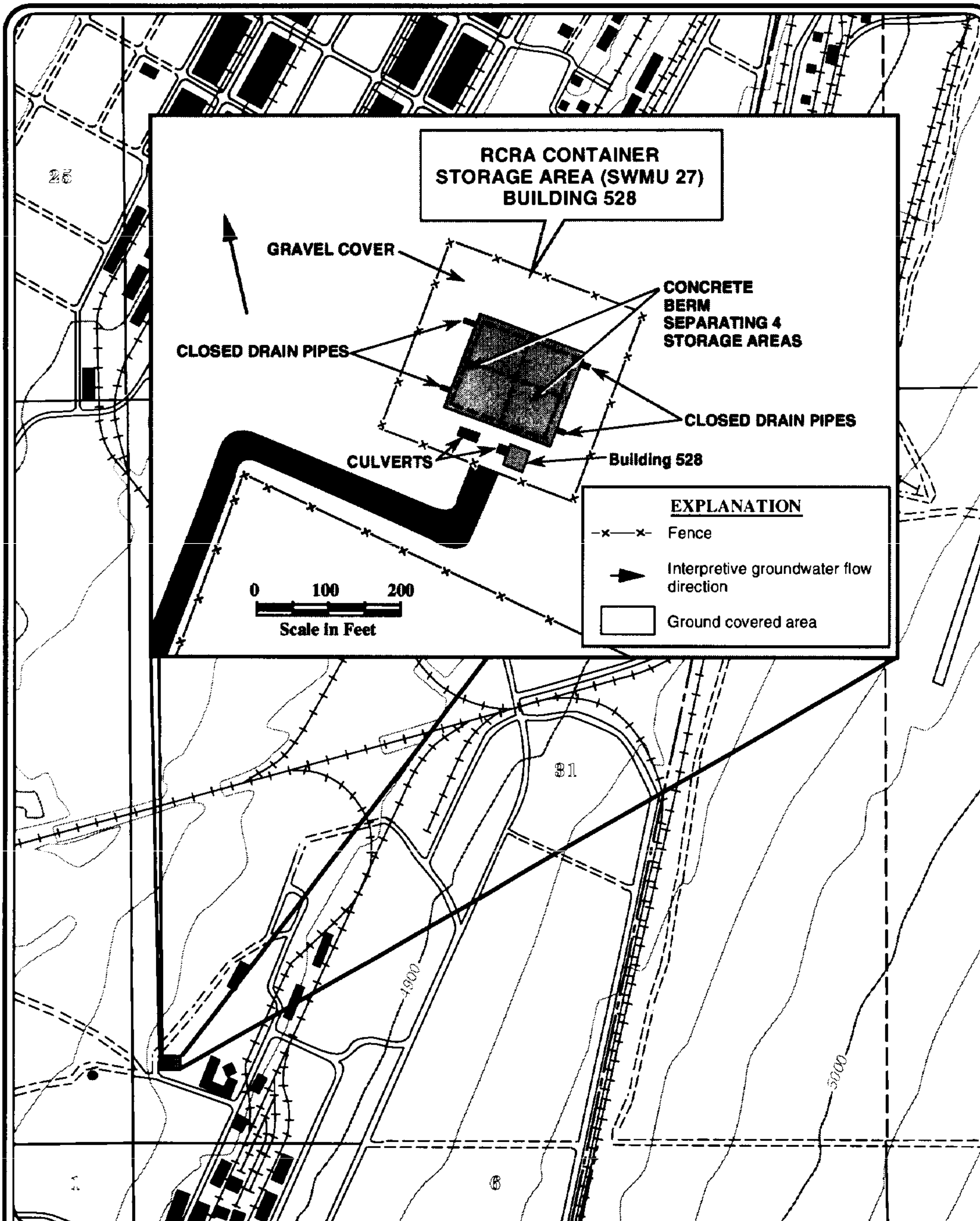
2.2.7.11. Scrap Metal Storage. During Jordan's 1989 site visit, miscellaneous scrap metal from vehicles, aluminum siding, and other equipment was observed in various sections of the DRMO Storage Yard (Jordan, 1989a).

2.2.7.12. DRMO Storage Yard Physical Setting. Based on previous investigations in the nearby maintenance areas, soils beneath the DRMO yard area consist of interlayered fine-grained silts and clays and coarse-grained gravels and sands (JMM, 1988). Bedrock is approximately 700 feet bgs (ERTEC, 1982). The regional water table is approximately 370 feet bgs and the groundwater flow direction is toward the northwest (JMM, 1987).

2.2.7.13. Previous Investigations. No previous environmental field investigations have been conducted at the DRMO Storage Yard. In addition, specific contaminants expected at this site are hard to predict because a large volume of diverse types of wastes have been stored at this site during more than 30 years of operation.

2.2.8. RCRA Container Storage Area (SWMU-27)

2.2.8.1. Site Description. The RCRA Container Storage Area is a locked building (Building 528) that is completely surrounded by perimeter chainlink fences in the N TEAD Administration Area. The floor slab was constructed in 1980 and the building added in 1986. This facility, which is depicted in Figure 2-11, is RCRA-permitted for long-term storage of hazardous waste generated at N TEAD. Wastes stored in this building are



Source: Modified from USGS Tooele 7.5 minute quadrangle.

JMM

SWMU-27
RCRA CONTAINER
STORAGE YARD
FIGURE 2-11

PROJECT NO. 2942.0120

those that will require treatment before land disposal. During a site visit in 1989, approximately 900 55-gallon drums containing a variety of wastes were stored in the building (JMM, 1989). The containerized wastes are segregated according to their chemical characteristics by "+"-shaped concrete berms that divide the building into four storage areas. Ignitable wastes, such as solvents, oils, paints, paint filters, thinners, and enamels, are stored in Areas 1 and 3. Area 2 contains ash from the heating plant furnace and plating solutions from metal plating shops. Corrosives, (acids and bases) including nitric acid, sulfuric acid, hydrochloric acid and sodium hydroxide are stored in Area 4.

2.2.8.2. The concrete floor slab that forms the base of building 528, is frequently inspected for cracks through which a spill could leak. To date, only small cracks have occurred in the slab and these have been sealed with caulking to keep the floor water-tight (Fisher, 1991). The inside perimeter of Building 528 is completely surrounded by concrete berms to contain hazardous material spills. Each of the four storage areas are connected to separate PVC drain lines that extend through the perimeter wall outside the building. The end of each drain pipe is closed by a brass spigot. If a spill occurs, these pipes drain the spilled liquid through the perimeter wall outside the building where it is collected and containerized from the spigots. The outside of Building 528 is surrounded by a gravel surface and a chain-link fence. Originally, this facility did not have a roof, and these drain pipes were apparently used to drain rainfall from within the bermed area (JMM, 1989). During the Fall 1989 Jordan visit, approximately 30 to 40 full drums were stored outside the fenced area of Building 528 awaiting transportation for off-site disposal. These drums were staged on pallets and labeled according to their contents, which included industrial waste sludge, fuels, solvents, detergents, paint sludges, fiberglass filters, used polyurethane, 1,1,1-trichloroethane, soluble oil coolant, and thinners (Jordan, 1989a). In addition, numerous empty polyethylene overpack drums were stored inside the fence.

2.2.8.3. Physical Setting. The soils in the area of SWMU-27 are silty gravels and the depth to groundwater is approximately 380 feet bgs. The direction of groundwater flow is toward the northwest (JMM, 1987). The depth to bedrock is approximately 1,500 feet bgs (ERTEC, 1982).

2.2.8.4. Previous Investigations. No previous environmental field investigations have been conducted at the RCRA Container Storage Area. Although three ruptured drums were observed inside the building during a site inspection in 1986, there is no evidence or data to indicate that hazardous materials were released to the environment (NUS, 1987). Storage areas are contained with concrete floors and berms to prevent chemical releases. Due to the design of this facility and the low potential for chemical releases, no action is recommended at this site and it is not included in the field investigation program detailed in Section 4.0.

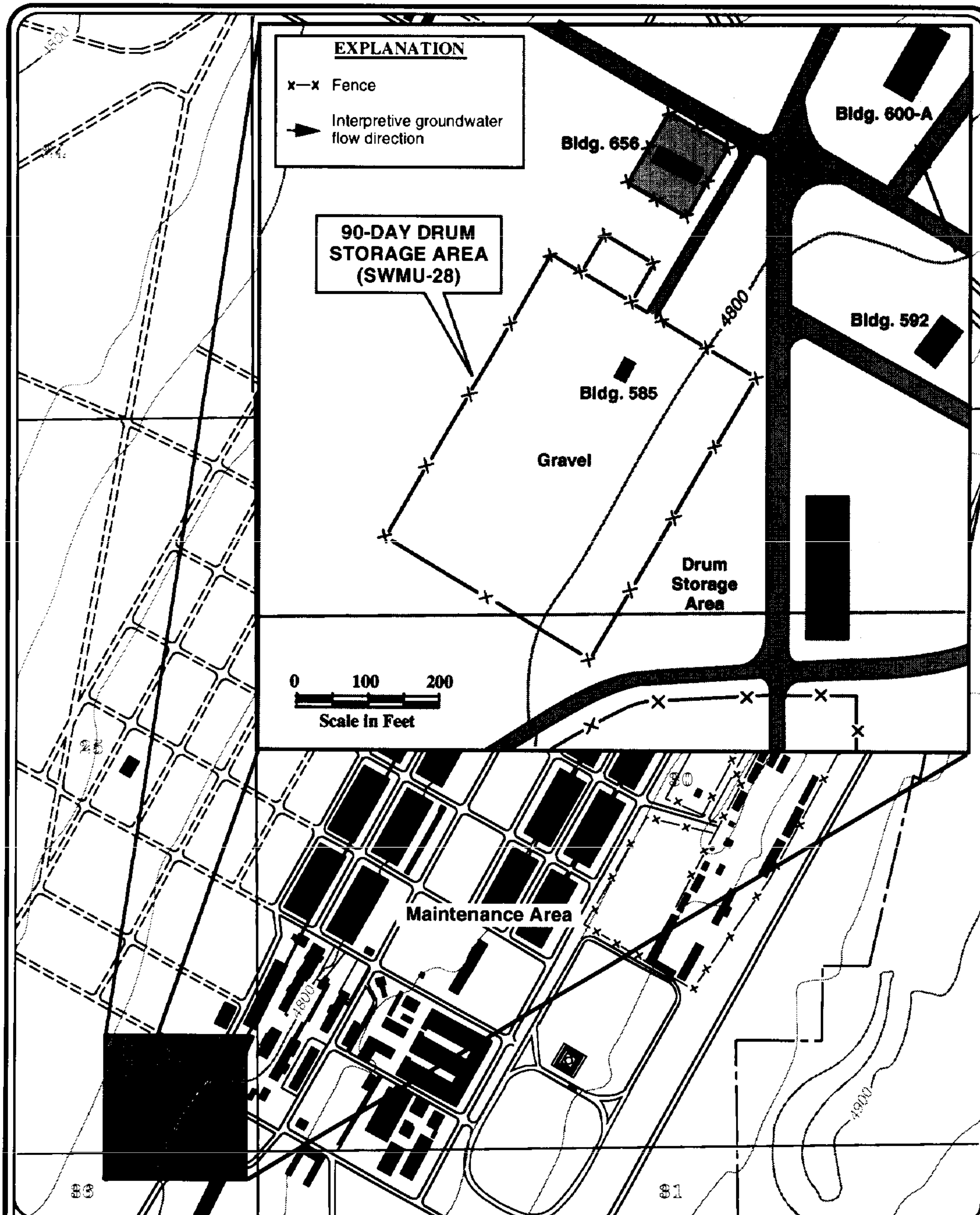
2.2.9. 90-Day Drum Storage Area (SWMU-28)

2.2.9.1. Site Description. The 90-Day Drum Storage Area, shown in Figure 2-12 is a 3.4-acre fenced lot located near the southern end of the Maintenance Area. It is located adjacent to the northern region of the Drum Storage Area (SWMU-29) and immediately east of the Sanitary Landfill (SWMU-15). EPIC photographs (from 1953, 1959, 1966, and 1981) indicate that, until approximately 1983 when the facility was constructed, drums were never stored within the perimeter of the 90-Day Drum Storage Area (USEPA, 1982).

2.2.9.2. Drummed wastes, including gasoline, phosphoric acid, sodium hydroxide, paint wastes, thinners, solvents, paint filters, and blast grit, are stored above ground on pallets in this area. The ground surface is covered by imported gravel (Mander, 1989). Drums remain sealed and are stored up to 90 days before they are moved off the depot to a hazardous waste management facility by a contractor or to the permanent storage facility in Building 528. This site is not included in the N TEAD RCRA permit; however, it has interim status and is listed on the N TEAD Part A application as a 90-day storage area (Fisher, 1990).

2.2.9.3. The available EPIC photographs show that the site was previously used for vehicle storage (USEPA, 1982). The 1953 EPIC photograph shows vehicles parked in rows running north and south across the site. Little activity is evident in the 1959 and 1966 photographs. In 1981, the site was covered by what is described as "broken vehicles" arranged in a roughly rectangular shape. No ground staining or standing liquid is evident on-site in any of the available EPIC photographs (USEPA, 1982).

2.2.9.4. Physical Setting. The approximate depth to the regional groundwater table is 300 feet bgs and the direction of groundwater flow is toward the northwest (JMM, 1987). The depth to bedrock is approximately 1,250 feet bgs (ERTEC, 1982).



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

0 1000
Scale in Feet

SWMU-28
90-DAY DRUM STORAGE AREA
FIGURE 2-12

PROJECT NO. 2942.0120

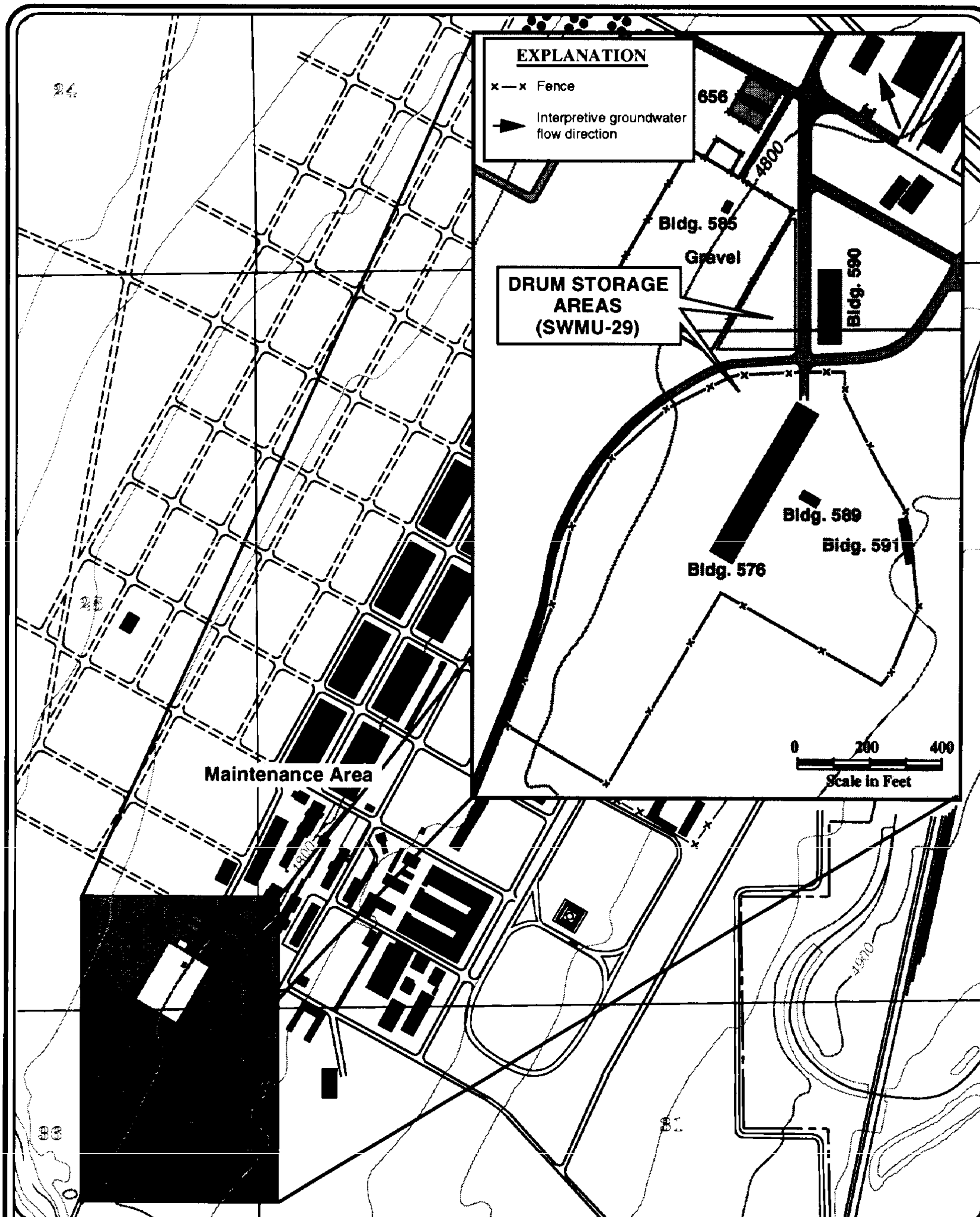
2.2.9.5. Previous Investigations. Other than the aerial photographic information, no previous environmental field investigations have been conducted at the 90-Day Drum Storage Area. It appears unlikely that past activities at this site could have resulted in a contaminant release. In addition, the present waste management practices in this area allow for proper storage, handling, and inspection of hazardous wastes stored at this facility. For these reasons, no action is recommended at this site and it is not included in the field investigation program detailed in Section 4.0.

2.2.10. Drum Storage Areas (SWMU-29)

2.2.10.1. Site Description. This SWMU consists of two Drum Storage Areas (northern and southern) located near the southern end of the Maintenance Area as shown in Figure 2-13. These two areas, which lie adjacent to each other, are separated by an unnamed road. The southern area, or "old lumber yard," is a fenced, 25-acre expanse of gravel and broken asphalt surface with a single warehouse (Building 576). Currently, Building 576 stores hazardous materials used at N TEAD. During a site visit in November 1989, Jordan personnel observed no vehicles, debris, or containers stored outside this building (Jordan, 1990b). Each of the four EPIC aerial photographs show drums stored at the southern area (USEPA, 1982). Cylinders, tank trucks, and lumber are visible in these photographs. Three SWMUs are located in the vicinity of the Drum Storage Areas: SWMU-28 (the 90-Day Drum Storage Area), and SWMUs-12 and -15 (the Sanitary Landfill, and the Pesticide Disposal Area within the Sanitary Landfill).

2.2.10.2. The northern region is a triangular-shaped, sparsely vegetated, open area of approximately five acres (see Figure 2-13). A 1953 aerial photograph shows drums stored in this area while aerial photographs taken in 1959 and 1966 indicate that the drums have been removed and that the area was unoccupied. In 1981, an aerial photograph shows debilitated vehicles stored in the western part of this area.

2.2.10.3. The Drum Storage Areas were used to store empty drums before they were returned to the originating contractor (EA, 1988). Empty drums were stored upside down to allow residual contents to drain and keep precipitation out. Chemicals which may have been released by drums in the two areas are reported to be solvents, degreasers, and oils (EA, 1988). The 1959 and 1966 aerial photographs identify a portion of the southern area as a "Pesticide Storage Lot."



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

0 1000
Scale in Feet

SWMU-29
DRUM STORAGE AREAS
FIGURE 2-13

PROJECT NO. 2942.0120

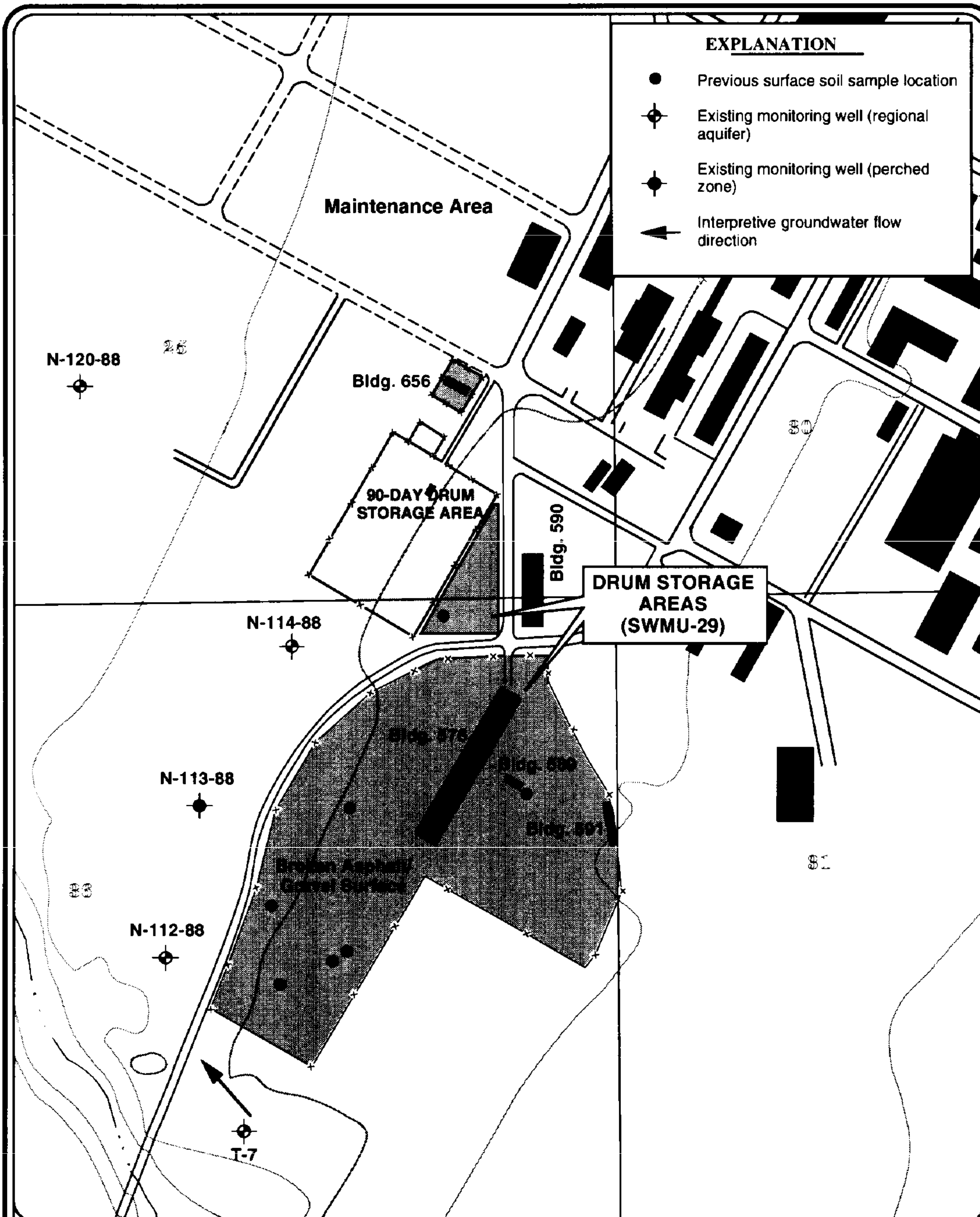
2.2.10.4. Physical Setting. The surface of most of the southern region of this SWMU is covered by deteriorating asphalt, while in the northern region natural vegetation is present. Soils consist of silty gravels. The approximate depth to the regional groundwater table is 300 feet bgs and the direction of groundwater flow is toward the northwest (JMM, 1987). The depth to bedrock is approximately 1,250 feet bgs (ERTEC, 1982).

2.2.10.5. Previous Investigations In 1989, Weston conducted a Remedial Investigation (RI) at the Drum Storage Areas (Weston, 1990). Prior to the Weston Study, no environmental investigations had been conducted at this site. Investigative work included surface soil sampling, monitoring well installation, and groundwater sampling and analysis. Results of the RI are discussed below.

2.2.10.6. Surface Soil. Soil samples were collected from eight locations across the site at three depths: 0 to 0.5 feet, 0.5 to 1.0 feet, and 1.0 to 2.0 feet. Locations of surface soil samples are shown in Figure 2-14. Twenty-four samples were collected and analyzed for VOCs, SVOCs, explosives, metals, pesticides, PCBs, and anions. Sample locations were chosen based on observed staining of the gravel and broken asphalt surface. Sampling results indicated that the surface soils were not widely contaminated. Volatile organic compounds, pesticides, PCBs, or explosives were not detected in any of the samples. However, polynuclear aromatic hydrocarbons (PAHs) were detected in all of the samples. Weston concluded that the asphalt that partially covers the area was probably the source of the PAHs.

2.2.10.7. Detectable levels of arsenic, cadmium, chromium, copper, sodium, nickel, lead, and zinc were present in a number of surface soil samples However, analyses of background soil samples at N TEAD are insufficient to establish whether the presence of these metals are significantly above naturally occurring concentrations. Chloride was the only anion detected; however, the presence of this anion cannot be attributed to a release from the facility because an elevated level of chloride was also present in a rinsate blank. No potential chemicals of concern were selected for surface and near-surface soils based on the RI sampling and analysis results (Weston, 1990).

2.2.10.8. Subsurface Soil and Groundwater. Three wells were installed downgradient of the Drum Storage Areas, and subsurface soil samples were collected from each of the three



Source: *Modified from Weston, 1990.*

JMM

0 200 400
Scale in Feet

SWMU-29
RI SAMPLING LOCATIONS AT THE DRUM STORAGE AREAS
FIGURE 2-14

PROJECT NO. 2942.0120

borings for chemical analysis (Figure 2-14). Two wells were sampled, and the third was dry at the time of sampling. Soil and groundwater samples were analyzed for VOCs, SVOCs, explosives, pesticides, PCBs, total and dissolved metals, and anions. Based on results of the analyses, Weston identified bis(2-ethylhexyl)phthalate, mercury, and selenium as potential chemicals of concern for subsurface soils. Bis(2-ethylhexyl)phthalate, silver, arsenic, beryllium, chromium, copper, nickel, lead, and zinc were selected as potential chemicals of concern for groundwater (Weston, 1990b). Trichloroethylene was also included in the groundwater list because it was detected in well N-120-88 located downgradient of the Drum Storage Areas and the Sanitary Landfill (SWMUs-12 and -15). However, this well lies within 700 feet of the Closed Industrial Waste Lagoon Outfall Ditch B which is a known source of trichloroethylene contamination in groundwater.

2.2.10.9. Other than the trichloroethylene in well N-120-88, no VOCs, pesticides, PCBs, or explosives were detected in subsurface soil or groundwater samples. Bis(2-ethylhexyl)phthalate was detected in groundwater in the sample from N-114-88 and in soil from well N-112-88. Because this compound was not detected in soil at N-114-88, it is believed to be a laboratory contaminant or sampling artifact. However, the unusually high concentration of this chemical in the groundwater sample warrants its selection as a potential contaminant of concern.

2.2.10.10. Concentrations of metals in groundwater downgradient of the Drum Storage Areas vary significantly compared to concentrations in cross gradient wells. It is possible the elevated metals are a result of well construction materials or contamination from either the Sanitary Landfill, the Closed Industrial Lagoon Outfall Ditch, or the Drum Storage Areas.

2.2.11. Pesticide Handling and Storage Area (SWMU-34)

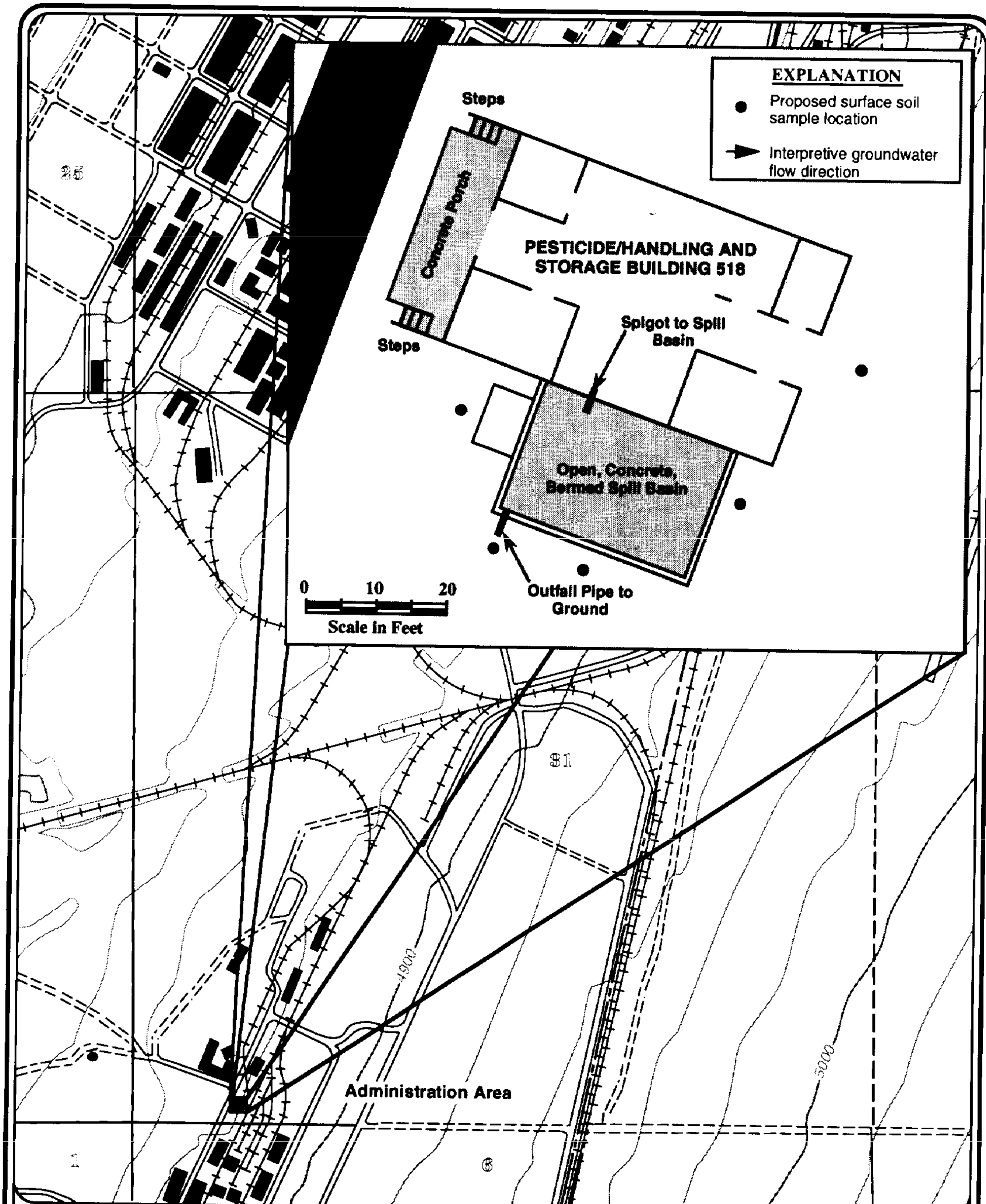
2.2.11.1. Site Description. The Pesticide Handling and Storage Area is located in Building 518 in the Maintenance Area. This facility is constructed of flame-retardant material and has bermed, sealed concrete floors. Pesticides, herbicides and other poisons are stored in separate, vented, locked rooms. The mixing/formulation area, located in the same building, but separated from the storage area by bermed concrete, is vented and equipped with backflow prevention devices on the water line. In recent years, a bermed concrete pad for loading sprayer trucks has been added to the south side of the building. The storage facility is labeled and secured with a chain link fence (EA, 1988, and Jordan, 1989a). The Pesticide Handling and Storage Area is depicted in Figure 2-15.

2.2.11.2. The building has been used for storing and handling pesticides since approximately 1942 (Smith, 1990). Activities associated with the building include storage and mixing/formulation of pesticides, filling tanks with pesticides, and rinsing containers. Pesticides stored at this site in the past included DDT (dichlorodiphenyl trichloroethane), 2,4-D (2,4-dichlorophenoxy acetic acid), and Round-Up (N-(phosphonomethyl) glycine) (NUS, 1987). During a previous site visit no stocks of "banned-use", outdated, or otherwise "excess" pesticides were stored in Building 518, with the exception of one 12 ounce bottle of strychnine and 19 one-liter bottles of the fumigant Vapona (2,2-dichloromethyl methyl phosphate) (EA, 1988). At the time of the inspection, these banned-use pesticides were awaiting proper disposal at an off-site location.

2.2.11.3. According to a preliminary assessment/site investigation (PA/SI) conducted by Engineering Science (EA), current practices at this building appear to meet AEHA guidelines and federal requirements (EA, 1988). The pesticides are stored in separate, vented locked rooms. Only certified pest control personnel handle the pesticides. Disposal of pesticide containers is conducted through a subcontractor at an off-depot treatment and disposal facility. On-site disposal of obsolete pesticides at N TEAD ended in the early 1980s (EA, 1988). Past handling and disposal of potentially hazardous pesticides may have resulted in releases to the environment in the vicinity of the pesticide handling and storage building.

2.2.11.4. Drains in the building were originally discharged via an eight-inch diameter underground pipe to the Stormwater Discharge Area (SWMU-45) located approximately 4,000 feet northwest of the building (Smith, 1990). An investigation of SWMU-45 is included as a separate task in this RFI. Currently, there are no discharges from the pesticide handling and storage building. The drains have been blocked and wash water is contained in a catch tank located on the north side of the building (Nichols, 1991).

2.2.11.5. A small outfall pipe extending through the berm in the batching and mixing area to the gravel surrounding the building was noted during a site visit by E.C. Jordan in the



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

JMM

0 1000
Scale in Feet

SWMU-34
PESTICIDE HANDLING AND STORAGE AREA
FIGURE 2-15

PROJECT NO. 2942.0120

Fall of 1989 (Jordan, 1989). At that time, an unidentified liquid was observed at the mouth of the outfall pipe.

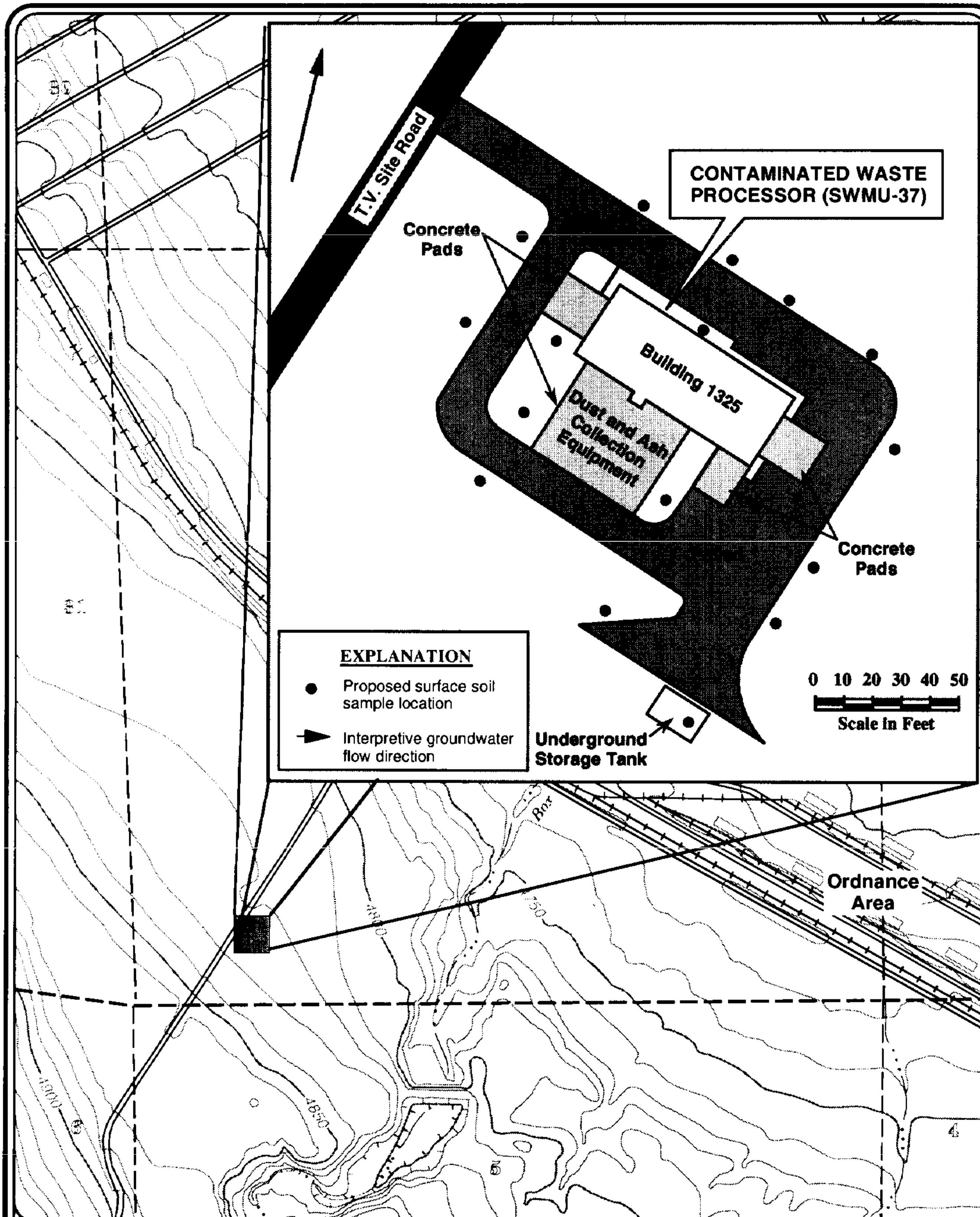
2.2.11.6. Physical Setting. Based on previous subsurface investigations conducted in the Maintenance Area, soils in this area consist of alternating layers of coarse-grained sands and gravels with fine-grained silts and clays (JMM, 1988). Depth to bedrock is estimated to be approximately 1,300 feet bgs, and the direction of groundwater flow is toward the northwest (JMM, 1987).

2.2.11.7. Previous Investigations. No previous environmental field investigations have been conducted at the Pesticide Handling and Storage Area. In addition, the lack of data regarding the volume and nature of pesticides discharged via the floor drains and outfall pipes makes it difficult to predict specific pesticides that may have been released to the environment.

2.2.12. Contaminated Waste Processor (SWMU-37)

2.2.12.1. Site Description. The Contaminated Waste Processor (CWP) is an incinerator located in the southwestern portion of N TEAD west of the Ordnance Area. The CWP consists of one large building, Building 1325, and another smaller storage building and adjacent staging and storage areas. The furnace is fired by diesel oil from an UST located south of Building 1325. Installed in approximately 1980, the CWP has been primarily used for flashing scrap metal and incinerating PCP-treated wooden crates, general packaging material (dunnage), scrap resins, and fabric contaminated with trace explosives (Bishop, 1990). This furnace differs from the furnaces at the AED Deactivation Furnace (SWMU-20) and the Deactivation Furnace Building (SWMU-21) in that it is a batch-type basket furnace rather than a rotary kiln. In addition, the CWP it is not used for deactivating munitions. Air pollution control equipment, installed at the same time as the furnace, consists of a cyclone, gas cooler, and baghouse. The diagram in Figure 2-16 depicts the site layout.

2.2.12.2. Although the CWP has been permitted to conduct experimental burns on hazardous wastes (e.g., production line wastes from paint lines and explosive wastes), it has been permitted to burn only solid waste. During an inspection of the CWP by the Utah Department of Environmental Quality (UDEQ) in March, 1990, the inspector noted that the



Source: *Modified from USGS Grantsville 7.5 minute quadrangles.*

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Scale in Feet

SWMU-37
CONTAMINATED WASTE PROCESSOR
FIGURE 2-16

PROJECT NO. 2942.0120

facility was being used to incinerate wastes contaminated with traces of explosives (Snyder, 1990). The wastes were deemed to be listed reactive wastes for which the CWP was not permitted. The facility was then ordered closed based on this inspection. The Environmental Management Office (EMO) is currently seeking UDEQ approval to restart the CWP to incinerate PCP-treated wooden crates that are continuing to be delivered to the SWMU (Snyder, 1990).

2.2.12.3. When the CWP is operating, all remaining metal debris are certified as clean and sent to the DRMO Yard (SWMU-26) for salvage. Incinerator ash, cyclone dust, and baghouse dust are drummed as hazardous waste and sent to the 90-day storage yard pending analysis and disposal.

2.2.12.4. Physical Setting. The soil surrounding the CWP is composed of sands and silty sands (Jordan, 1989). The ground surface under and around Building 1325 and at the Processor Staging Area is paved. The approximate depth to the groundwater table is 350 feet bgs, and the direction of groundwater flow is toward the north/northeast (JMM, 1987). The depth to bedrock is approximately 500 feet bgs (ERTEC, 1982).

2.2.12.5. Previous Investigations. Analyses of cyclone/baghouse dust and/or incinerator ash has detected lead and cadmium in concentrations that exceed the maximum levels specified by USEPA (40 CFR 261.24) for characterizing a waste as hazardous based on Toxicity (Bishop, 1990). In addition to metals, polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were found in ash and dust in the Air Pollution Control System after burning PCP-treated wood (AEHA, 1989). PCDDs and PCDFs are considered PCP-wastes and are therefore hazardous wastes (per 40 CFR 261, Appendix VIII). The highest levels of these contaminants were in baghouse dust and cyclone ash. Pentachlorophenol (PCP) was detected in all the samples of baghouse dust but not in the furnace ash. The presence of PCDDs and PCDFs has been confirmed in PCP-treated wood prior to burning in the CWP, and the incineration process appears to produce PCDDs and PCDFs. While the total levels of PCPs are high in CWP ash/dust, there were no detectable concentrations of PCP wastes in TCLP extracts (AEHA, 1989).

2.2.13. Industrial Wastewater Treatment Plant (SWMU-38)

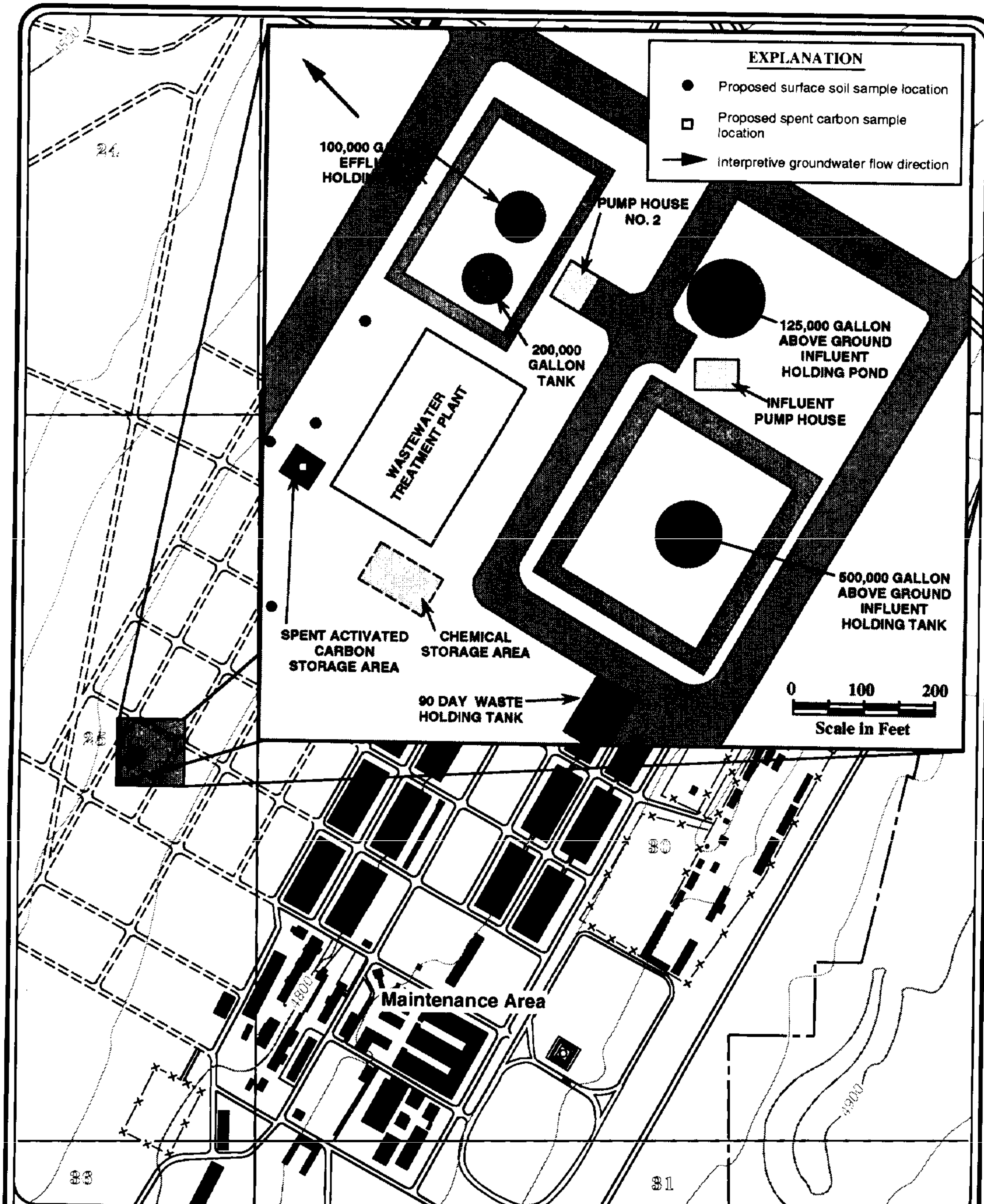
2.2.13.1. Site Description. Operation of the Industrial Wastewater Treatment Plant (IWTP) began in November 1988. The facility handles an average of about 116,000 gallons of wastewater daily. Of this total, an average of 102,611 gpd of the wastewater is recycled, and the remaining is discharged to the Tooele Publicly Owned Treatment Works (POTW)(Kinsinger, 1989). Treatment at the IWTP includes air strippers for VOC removal, a flocculator and clarifier for settling out metals, sand filters for filtering solids, and granular activated carbon to remove additional VOCs and SVOCs. General site features of the IWTP are depicted in Figure 2-17. The facility is not included in the N TEAD RCRA Part B Permit. Based on Jordan's 1989 site visit, the only waste handling or disposal concern noted at the IWTP is the storage of spent activated carbon in open shipping containers outside the facility (Jordan 1990b). During about a one-year period when the facility first opened, the shipping containers were left uncovered, and spent carbon apparently was blown from the shipping containers onto nearby surface soils along the west side of the facility.

2.2.13.2. Physical Setting. Portions of the site are paved, and the underlying soils are expected to consist of interlayered fine-grained silts and clays with coarse-grained sands and gravels. Bedrock is estimated to be 1,125 feet bgs (ERTEC, 1982). The regional water table is estimated to be 280 feet bgs, and direction of groundwater flow is toward the northwest (JMM, 1987).

2.2.13.3. Previous Investigations. Analyses of the spent activated carbon showed elevated levels of VOCs, including 344 µg/g 1,1,1-trichloroethane; 320 µg/g methylene chloride; 571 µg/L 1,2-dichlorobenzene; 6,633 µg/L 2,4,6-trichlorophenol; 496 µg/L 2-chlorophenol; 771 µg/L 2-nitrophenol; and 5,4124 µg/L 4-nitrophenol. Semi-VOCs were also detected, including 4,403 µg/L bis(2-ethylhexyl) phthalate. EP Toxicity analysis for metals detected 0.17 mg/L barium and 0.03 mg/L cadmium (EMO, 1989).

2.2.14. Solvent Recovery Facility (SWMU-39)

2.2.14.1. Site Description. The Solvent Recovery Facility (Building 600B), as shown in Figure 2-18, is located at the west side of the maintenance area of N TEAD. The facility was built in October, 1988 and annually distills approximately 10,500 gallons of waste



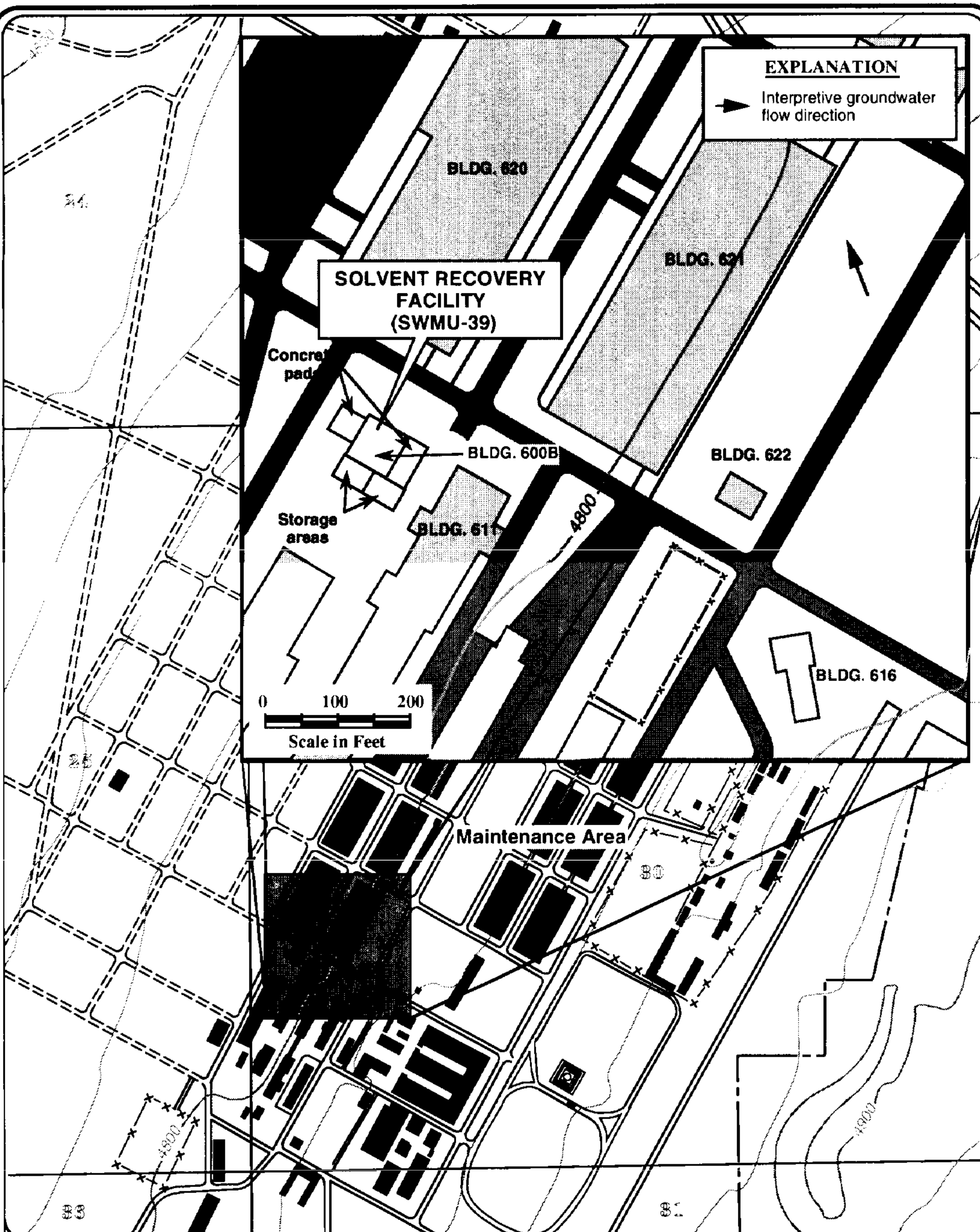
Source: Modified from USGS Tooele 7.5 minute quadrangle.

JMM

SWMU-38 INDUSTRIAL WASTE TREATMENT PLANT

FIGURE 2-17

PROJECT NO. 2942.0120



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

JMM

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Scale in Feet

SWMU-39
SOLVENT RECOVERY FACILITY
FIGURE 2-18

PROJECT NO. 2942.0120

solvent. Approximately 7,100 gallons of solvent are recovered while 2,100 to 2,250 gallons of waste is generated. The solvents that are currently recycled include 1,1,1-trichloroethane, Stoddard solvent, polyurethane thinner, and lacquer thinner. There are also plans to begin recycling phosphoric acid via distillation at the Solvent Recovery Facility (Allen, 1989).

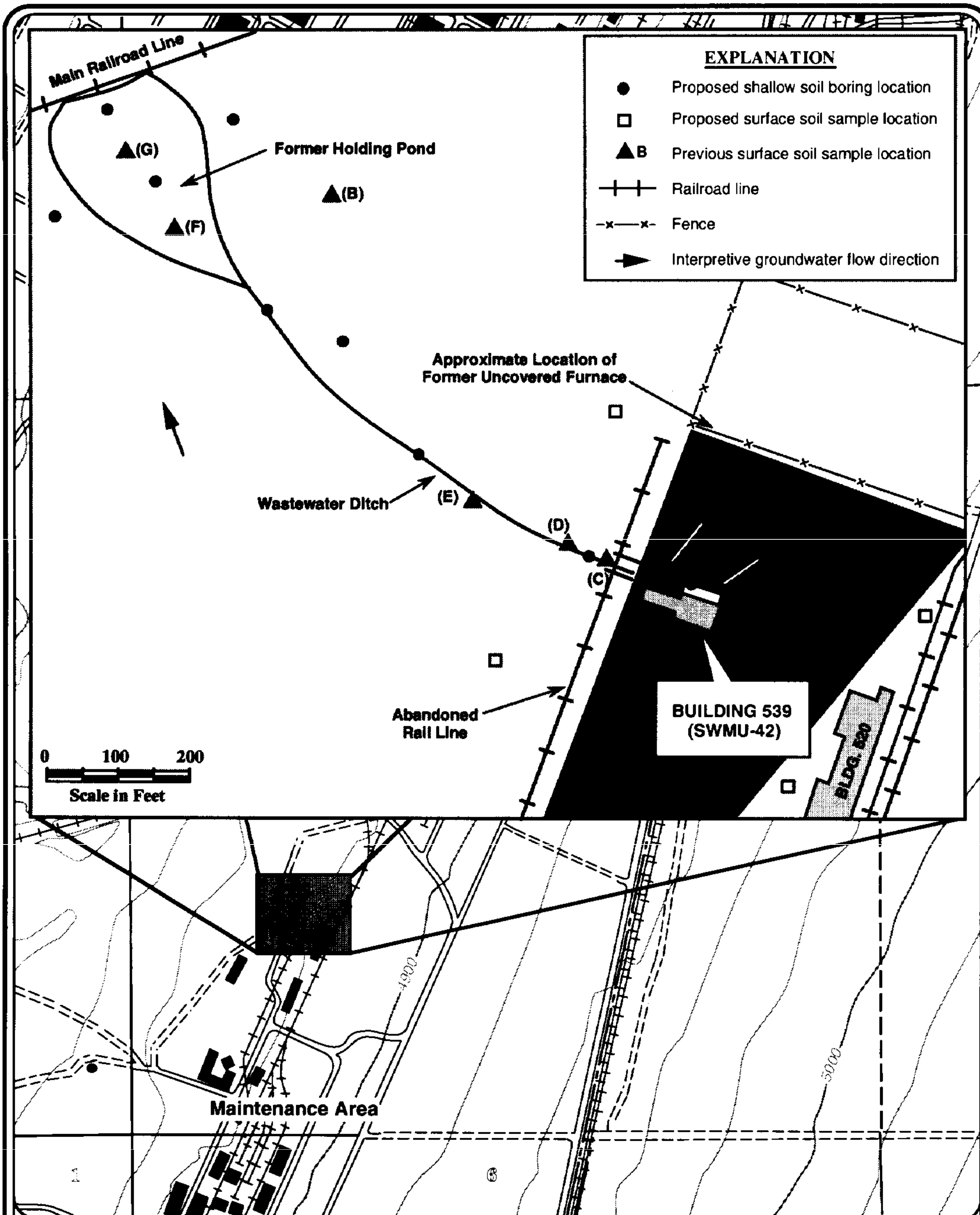
2.2.14.2. Building 600B contains pumps, a distillation unit, a condenser, and associated equipment for pumping waste solvent from drums and separating solvent from sludge (still bottoms). The building has explosion protection and is bermed on the inside to contain spills. The building floor is equipped with drains that would direct spills to the IWTP. Still bottoms are drummed and temporarily stored in a fenced concrete pad outside the building for future collection and disposal by a hazardous waste contractor. The concrete storage pad is equipped with concrete berms for spill containment.

2.2.14.3. Physical Setting. Concrete slabs and a concrete apron surround the building. Native soils are expected to be silty gravels. The approximate depth to the groundwater is 300 feet bgs and the direction of groundwater flow is toward the northwest (JMM, 1987). The depth to bedrock is approximately 1,000 feet bgs (ERTEC, 1982).

2.2.14.4. Because the facility is new and is equipped with adequate containment features and because proper work management practices are followed, no action is planned for this SWMU.

2.2.15. Bomb Wash Out Building (SWMU-42)

2.2.15.1. Site Description. The Bomb Wash Out Building (Building 539) is located in the northwestern portion of N TEAD in the Administration Area. The main site features are depicted in Figure 2-19. The site history and description were compiled from communications with N TEAD personnel (Mascarenas, 1990, and Clark, 1990). Building 539 is a wood frame building with a tin roof and concrete floor Between the early 1940s and the early 1960s, projectiles from small arms (.30 and .50 caliber) were burned in a retort furnace located in this building. Molten lead was reclaimed during the process in troughs located in the building beneath the furnace. The lead was then placed into molds to make ingots (measuring approximately 3 inches by 3 inches by 12 inches) that were later sold to private firms.



Source: Modified from USGS Tooele 7.5 minute quadrangle.

0 1000
Scale in Feet

SWMU-42
BOMB WASHOUT BUILDING
FIGURE 2-19

PROJECT NO. 2942.0120

2.2.15.2. Building 539 was never connected to the IWL or IWTP. According to N TEAD personnel, there are no floor drains in the building (Mascarenas, 1990). During operation, wastes from the incineration and lead reclamation process may have included splatter and spillage of molten lead onto the floor. When the building was cleaned, wash water was discharged via a steel lined concrete flume which extends from the northeast corner of the building. The flume, which is still present, runs east-west about 10 feet north of the building and discharges into an open ditch west of the building. The ditch extends approximately 600 feet into an unlined holding pond located in an open area west of Building 539 and south of the main line railroad tracks (see Figure 2-19). The holding pond, which is currently overgrown with weeds and sagebrush, was reportedly 50 feet in diameter and 1 to 2 feet deep.

2.2.15.3. During operation, the furnace generated a significant amount of visible smoke (Mascarenas, 1990). Because no air emission control devices (such as a baghouse or cyclone) were installed on the smokestack, heavy particulates from the smokestack flue would settle out into a steel, 4-foot by 4-foot by 6-foot deep, "drop-out box" located on the roof of the building. Potential airborne contaminants may have been released to the air due to emissions from the smokestack.

2.2.15.4. The furnace was dismantled sometime around 1960, and the building was used for storage until recently. The building is currently being renovated for use as a vehicle storage area, although it is not serviced with electricity or water. The steel drop-out box is still located on the roof of Building 539, and it is half-full of granulated metal debris. The area around the building is currently paved, although the pavement is broken in places. According to N TEAD personnel, it was probably paved sometime in the 1940s or 1950s (Mascarenas, 1990).

2.2.15.5. Reportedly, another furnace was located approximately 225 feet north of Building 539 (Mascarenas, 1990). This furnace, which was apparently not enclosed inside a building or covered, was used to incinerate fuses and other small munitions. This furnace is no longer present. During a recent visit by JMM personnel, footings and metallic lead residue were observed on the ground at the reported location (JMM, 1991). This furnace was reportedly about the same size as the one in Building 539, and was operated during the same time period (early 1940s to early 1960s)(Mascarenas, 1990).

2.2.15.6. Physical Setting. Soils beneath the pavement at Building 539 include silty sands and gravelly sands (Jordan, 1989). Little groundwater elevation data in the immediate vicinity of Building 539 exists; however, based on water levels measured by Jordan on June 13, 1990, depth to groundwater in this area is expected to be approximately 385 feet, and the direction of groundwater flow is toward the northwest (Jordan, 1990). Bedrock is approximately 1,500 feet bgs in this area (ERTEC, 1982).

2.2.15.7. Previous Investigations. On March 2, 1990, the EMO collected seven soil/waste samples from Building 539 and the associated ditch and former holding pond area. The sample locations, labelled "A" through "G", are shown in Figure 2-19. Descriptions of the sample locations are as follows:

- A Sample of granulated metal debris from the drop-out box located outside Building 539

- B Background surface soil sample from an area higher in elevation than the ditch or former pond

- C Surface soil sample from the downgradient end of the culvert

- D Surface soil sample 25 feet downgradient from the culvert

- E Surface soil sample 85 feet downgradient from the culvert

- F Surface soil sample from the southeast corner of the former holding pond (no water was present)

- G Surface soil sample from the center of the pond (no water was present).

All of the samples were analyzed for total metals, EP Toxicity metals, total organic halogens, VOCs, and RCRA characteristics for reactivity, pH, and ignitability.

2.2.15.8. According to the N TEAD EMO, none of the samples contained detectable levels of total organic halogens or VOCs. Several metals, including barium, cadmium, chromium, lead, mercury, nickel, and silver, were detected at concentrations that exceeded those in the background soil sample (sample "B") by one order of magnitude or more. The sample of granulated metal in the drop-out bin (sample "A") contained elevated total metal concentrations of barium (6,493.88 mg/kg), cadmium (31.78 mg/kg), chromium (171.77 mg/kg), lead (68,117.65 mg/kg), mercury (3.65 mg/kg), nickel (138.21 mg/kg), and silver (1.68 mg/kg). All soil samples from the ditch and pond area (C, D, E, F, and G) contained several metals at levels exceeding those in the background soil sample. Concentrations generally decreased as distance from the culvert increased. Four of the samples (i.e., C, D, E, and G) exceeded the maximum EP Toxicity concentration limits for barium (100 mg/L) and three of the samples (C, D, and E) exceeded EP Toxicity limits for lead (5.0 mg/L).

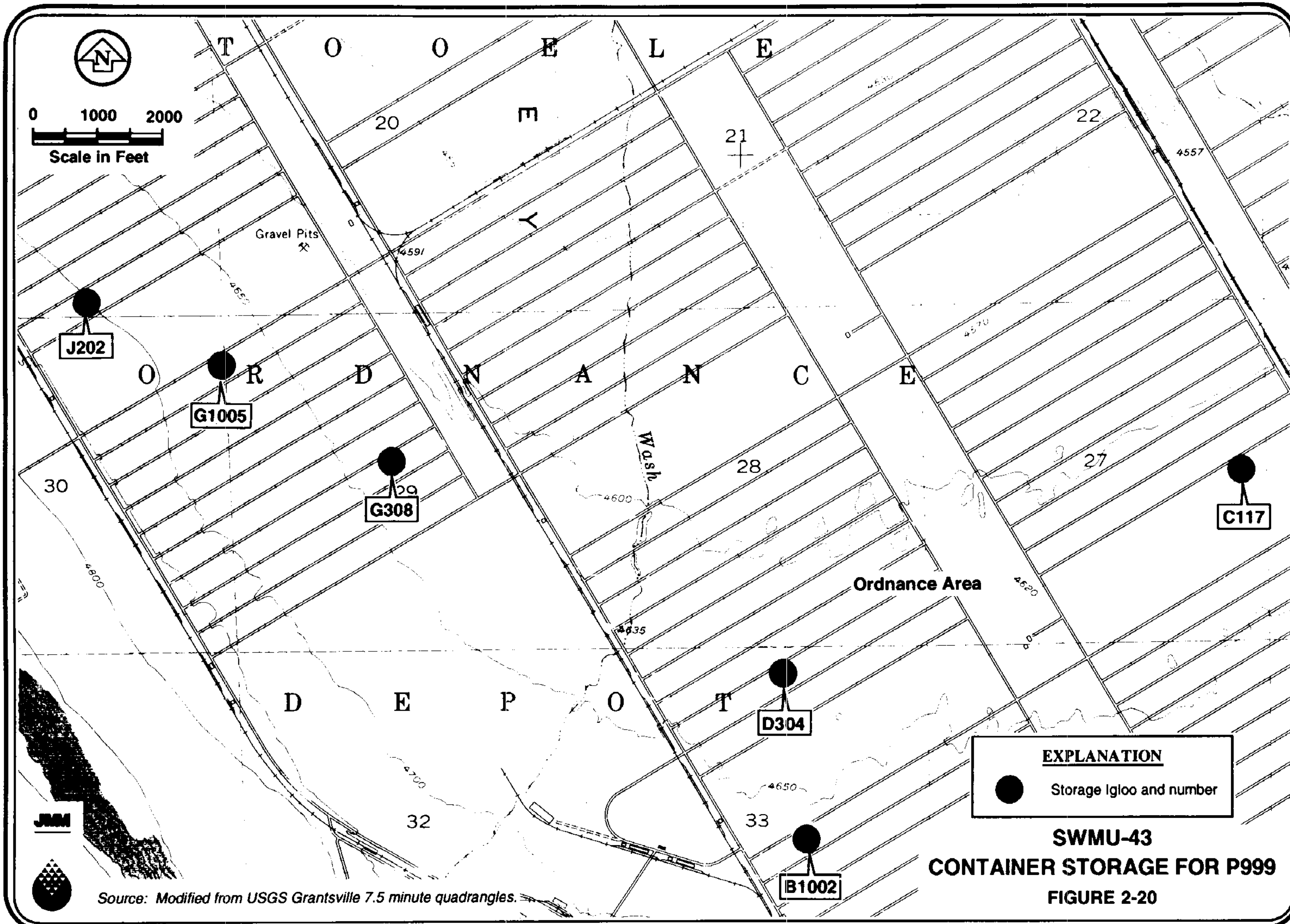
2.2.16. Container Storage Areas for P999 (SWMU-43)

2.2.16.1. Site Description. Six storage igloos (B1002, C117, D304, G308, G1005, and K202) located in the Ammunition Storage Area were used between 1985 and 1989 to store M55 rocket parts and fuses for use in rocket assessment tests. The rockets were received from Pine Bluff Arsenal and Umatilla Army Depot, and they were tested to check the stability of the rocket propellant. While the M55 rockets can be used to transport chemical warfare agents, the material stored in these bunkers did not contain chemical agents or warheads and never came into contact with them. Figure 2-20 depicts locations of the storage igloos included in SWMU-43.

2.2.16.2. Each storage igloo measures approximately 60 feet by 26 feet and is constructed from concrete and steel with a soil and grass covering. The roads serving the bunkers are paved, as are the driveways leading up to the entrances. Inside, the igloos have two troughs that empty into floor drains which are not connected to any treatment system, although no liquids have been used in the igloos. Materials that were stored in the six bunkers for the testing included shipping and firing tubes, M417 fuses, M23 rocket propellant, rocket motor metals parts, M67 rocket motor assemblies, adapters, and anti-resonance rods.

2.2.16.3. Physical Setting. Soils beneath the bunker area are composed of silty sands and gravelly sands. Little groundwater elevation data in the immediate vicinity of the bunkers exists; however, the groundwater is expected to be approximately 350 to 450 feet bgs

PROJECT NO. 2942.0120



SWMU-43

CONTAINER STORAGE FOR P999

FIGURE 2-20

and flowing toward the north (JMM, 1987). Bedrock is approximately 1,500 feet bgs in this area (ERTEC, 1982).

2.2.16.4. Previous Investigations. No previous environmental investigations have been conducted at these sites. No action is scheduled for this facility because the M55 rocket components stored in these bunkers did not contain or contact chemical agents or warheads. There is no reason to believe that contaminants have been released to the environment at this site and no additional work is planned for this SWMU during the N TEAD Phase I RFI field investigations.

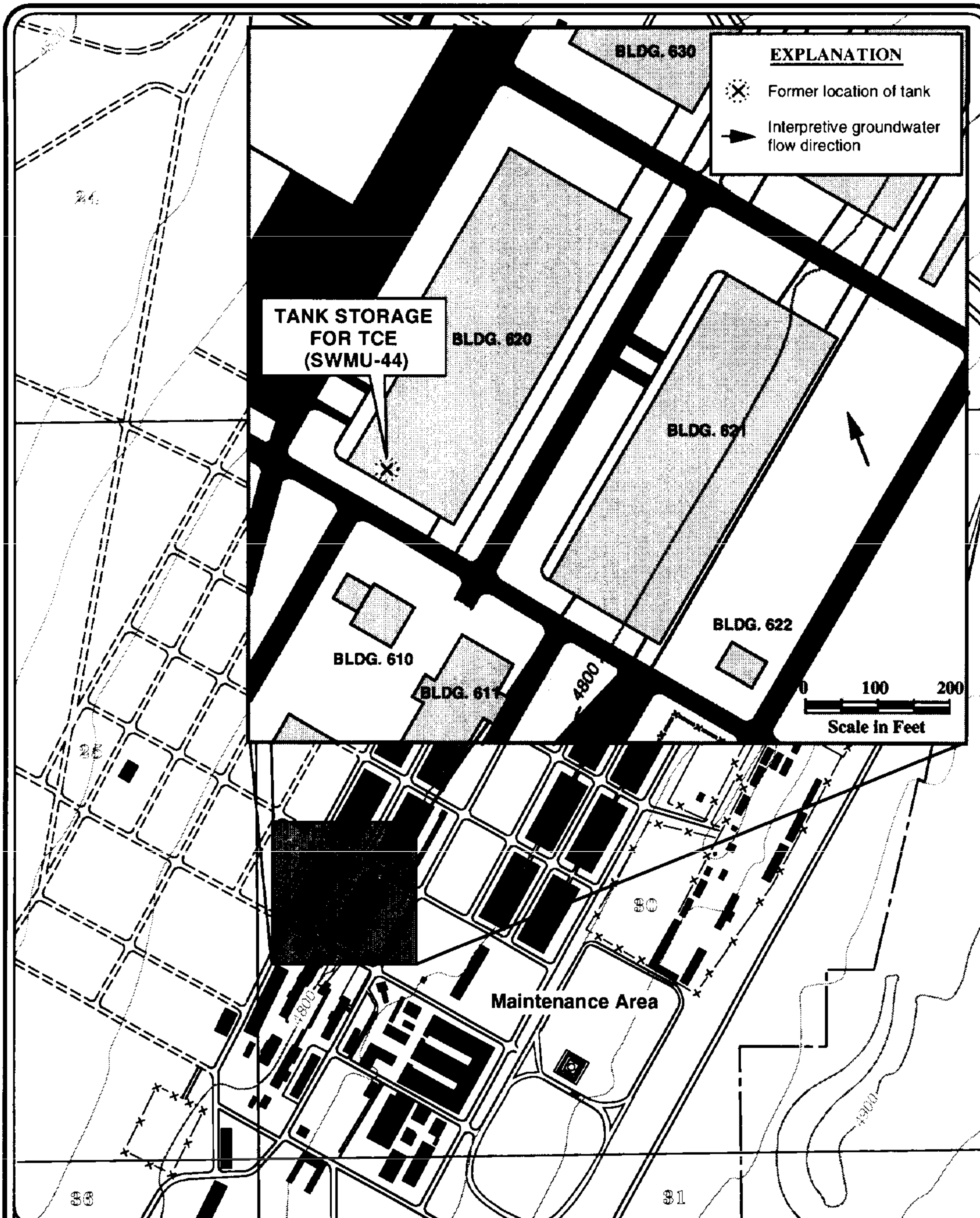
2.2.17. Tank Storage for Trichloroethylene (SWMU-44)

2.2.17.1 Site Description. The southern end of Building 620 in the maintenance area contained an above-ground 500-gallon trichloroethylene storage tank. The location of the tank is shown in Figure 2-21. From 1971 to 1984, the trichloroethylene was used to degrease small arms ammunition, gears, and small metal parts. The tank was emptied once a week during its heaviest usage in the 1970s. The tank drained into the sewers which ultimately emptied into the Industrial Wastewater Lagoon (IWL). In 1984, usage of the tank was discontinued but it was left in the building. During an inspection in February, 1990, potentially hazardous waste residue was observed in the tank. Within one week of the inspection, all residues and sludge were removed from the tank to the 90-day storage area for off-site disposal. In April, 1991, the tank was turned over to the DRMO yard for salvage (Siniscalchi, 1991).

2.2.17.2. All waste from this tank emptied into the IWL outfall ditches and lagoon. These facilities have been excavated and capped and remediation of the groundwater contamination plume associated with the IWL is planned to begin in late 1992 using a pump and treat system. Because neither the tank nor any contamination originating from the tank remains at the site no action is scheduled for this SWMU in the N TEAD Phase I RFI field investigation.

2.2.18 Stormwater Discharge Area (SWMU-45)

2.2.18.1. This SWMU is located approximately midway between the Maintenance and Administration Areas immediately north of a set of railroad tracks as depicted in



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

JMM

0 1000
Scale in Feet

SWMU-44
TANK STORAGE FOR TRICHLOROETHYLENE
FIGURE 2-21

PROJECT NO. 2942.0120

Figure 2-22. Stormwater from the Administration Area drains via underground piping to a small depression south of the Sanitary Landfill. A small pond forms at the discharge point and the presence of phreatophytes indicates saturated soil conditions.

2.2.18.2. Physical Setting. Soils in the stormwater discharge areas are expected to consist of silty sands and gravels. The depth to groundwater is approximately 300 feet bgs and groundwater flows toward the northwest. Although depth to bedrock is unknown, based on information from nearby wells, it is probably greater than 500 feet bgs.

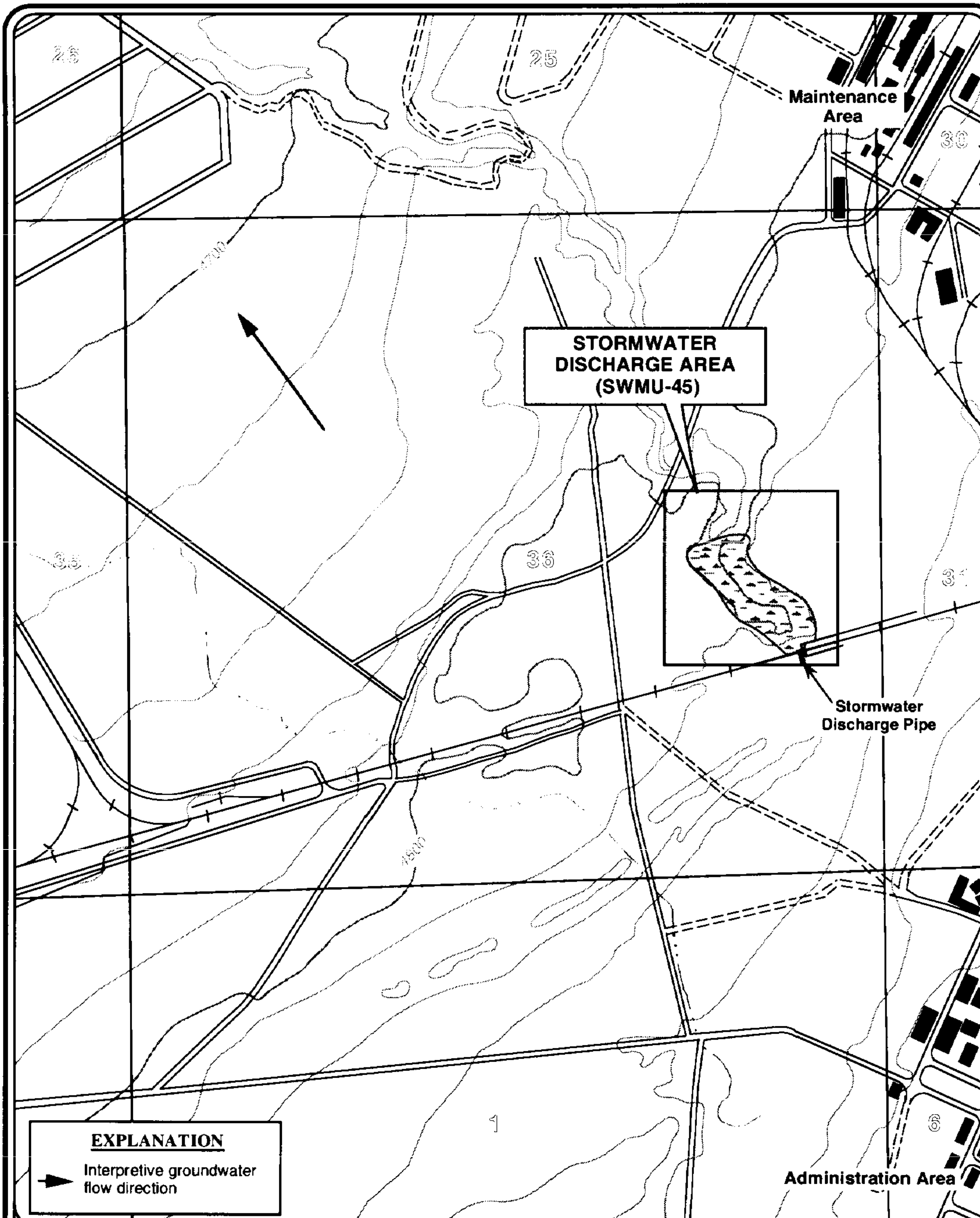
2.2.18.3. Previous Investigations. Surface water and sediment samples were collected in July 1990 by the EMO. The water sample contained 10 µg/L of methylene chloride. The sediment sample contained 40 µg/kg of methylethyl ketone, 350 µg/kg methylisobutyl ketone, and 1,175 µg/kg methylene chloride. Potential sources of these contaminants include the carpenter shop, sign shop, motor pool, rail shop, and pesticide storage area (SWMU-34).

2.2.19. Used Oil Dumpsters (SWMU-46)

2.2.19.1. Site Description. This SWMU has 14 locations: Buildings 507, 509, 510, 511, 522, 602, 607, 611, 619, 620, 621, 637, and 691, as shown in Figure 2-23. These buildings are used for overhauling and maintaining assorted equipment, including engines. Used oil generated from these processes is stored in dumpsters located at each of the buildings. One dumpster is present at each building, except buildings 600, 607, and 637, each of which have two. Used oil from the dumpsters is removed on a regular basis for off-site disposal by a hazardous waste contractor.

2.2.19.2. Physical Setting. Soils in the Maintenance and Administration Areas are expected to consist of mixtures of silt, sand and gravels. The depth to groundwater varies but is expected to be about 300 feet bgs. Groundwater flow beneath these areas is toward the northwest. The depth to bedrock is unknown but probably ranges from 300 to 500 feet bgs.

2.2.19.3. Previous Investigations. Sampling and analysis of used oil indicates detectable concentrations of benzene and other VOCs which may be considered hazardous waste constituents.



Source: Modified from USGS Tooele 7.5 minute quadrangle.

0 1000
Scale in Feet

SWMU-45
STORMWATER DISCHARGE AREA
FIGURE 2-22

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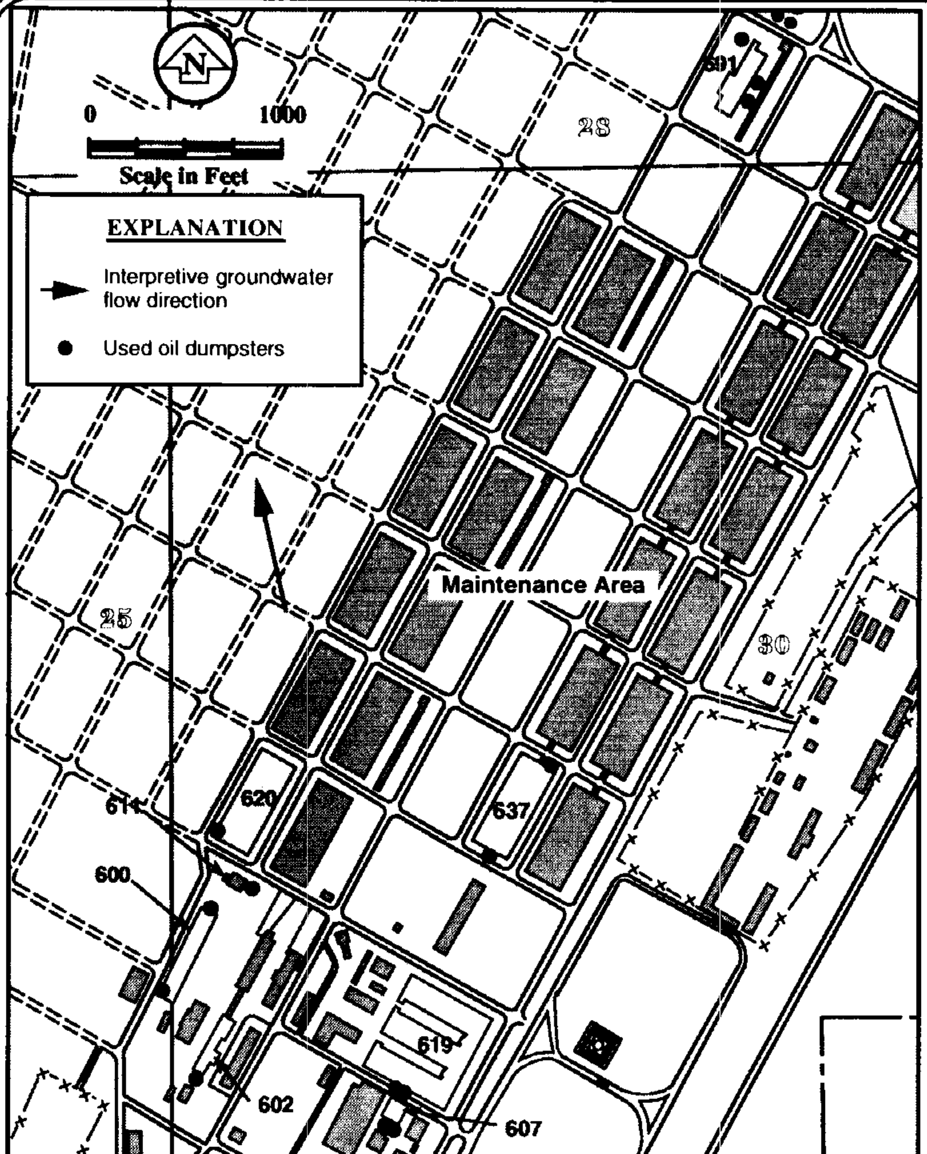
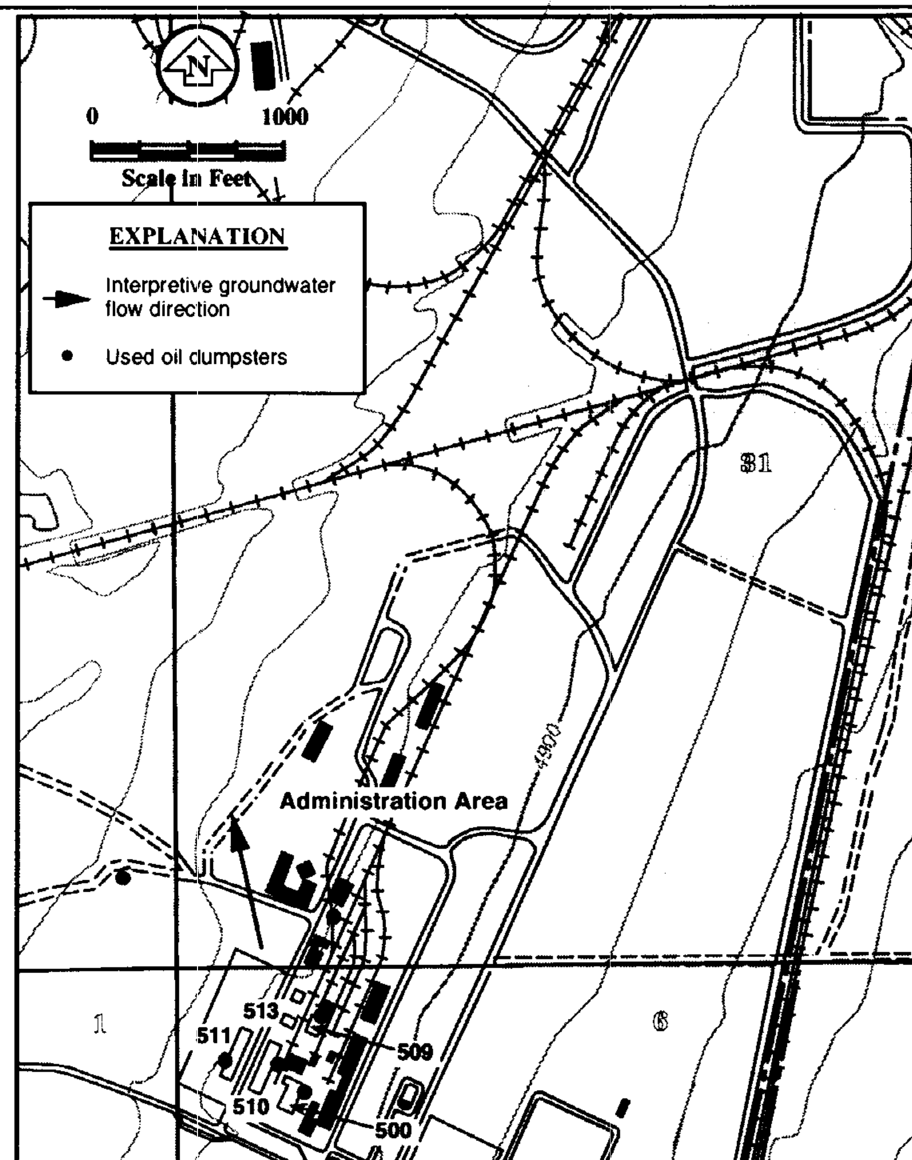
PROJECT NO. 2942.0120



MAINTENANCE AREA



ADMINISTRATION AREA

JMM

Source: Modified from USGS Tooele 7.5 minute quadrangle.

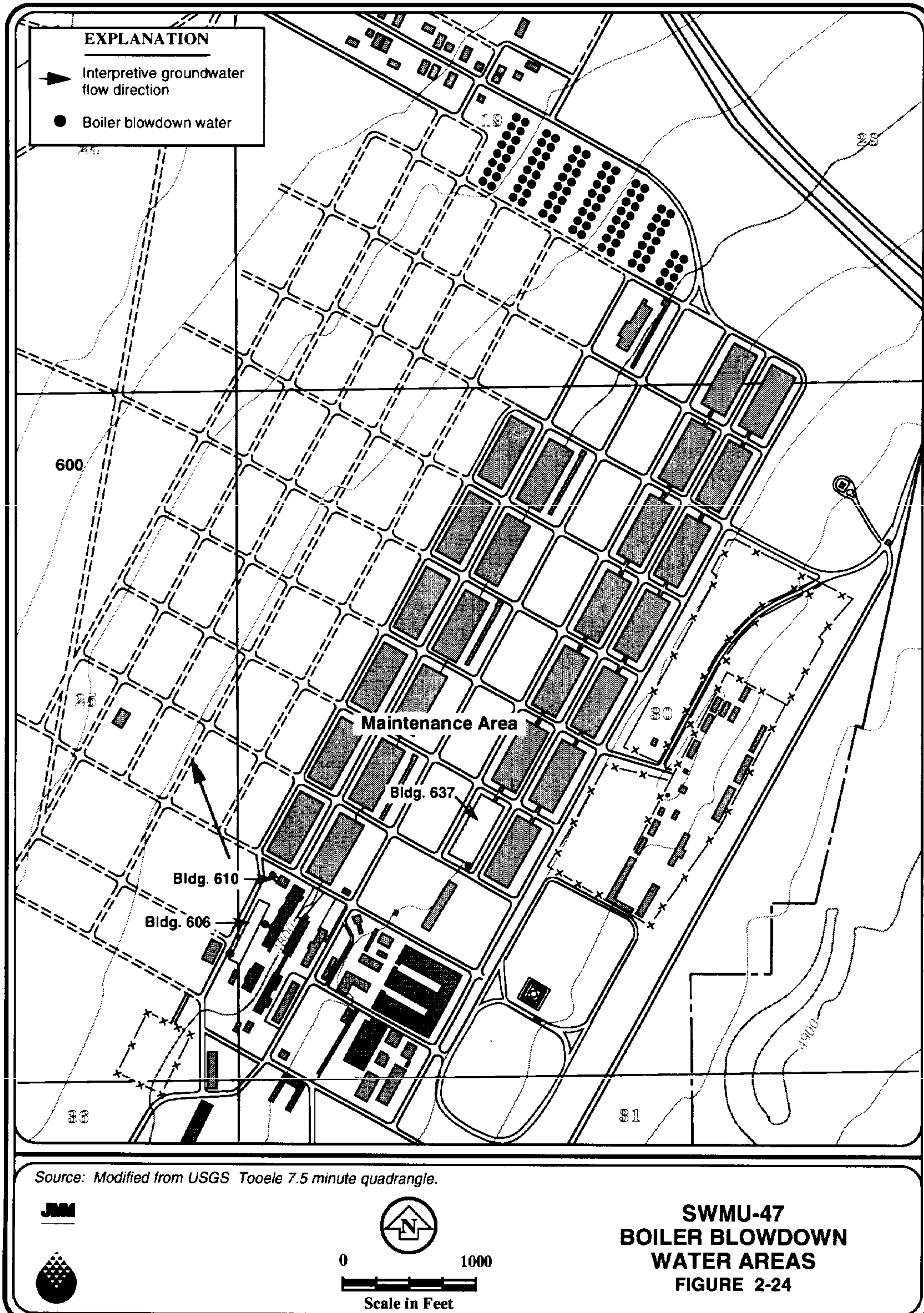
SWMU-46
USED OIL DUMPSTERS
FIGURE 2-23

2.2.20. Boiler Blowdown Water (SWMU-47)

2.2.20.1. Site Description. This SWMU has three locations: Buildings 606, 610, and 637 shown in Figure 2-24. Each of these buildings contain boilers which generate steam. During boiler plant maintenance, the boiler is backflushed during a blowdown that produces small amounts of blowdown water. Tannic acid, a plant-derived compound, is used to reduce scale buildup inside the boiler during this process and it gives the blowdown water a reddish color. Boiler blowdown water is discharged from the boiler buildings to the IWTP.

2.2.20.2. Physical Setting. Soils in the maintenance and administration areas are expected to consist of mixtures of silt, sand, and gravels. The depth to ground water varies but is expected to be about 300 feet bgs. Groundwater flow beneath these areas is toward the northwest. The depth to bedrock is unknown but probably ranges from 300 to 500 feet bgs.

2.2.20.3. Previous Investigations. No previous investigations have been conducted of the boiler blowdown water.



SWMU-47
BOILER BLOWDOWN
WATER AREAS
FIGURE 2-24

PROJECT NO. 2942.0120

3.0 REGIONAL PHYSICAL SETTING

3.1 INTRODUCTION

3.1.0.1. Section 3.0 describes the regional physical setting of N TEAD. Included in this section are discussions of the geographic setting, geology, soils, hydrology, hydrogeology, ecology, demography, and land use of the N TEAD area. Most of these topics have been well documented in previous investigations, particularly in the *Groundwater Quality Assessment Engineering Report to the Tooele Army Depot, Utah*, prepared by JMM (JMM, 1988), and the *Tooele Army Depot, Preliminary Assessment/Site Investigation Final Draft Report, Volume I - North Area*, prepared by Engineering Science and Technology (EA, 1988). These reports comprehensively assess the regional hydrology, geology, and hydrogeology of the N TEAD area. Much of the information in the following sections is taken from the JMM and EA reports.

3.2 GEOGRAPHIC SETTING

3.2.0.1. North Tooele Army Depot is located in the southern portion of Tooele Valley. Tooele Valley is bounded on the north by the Great Salt Lake at an elevation of approximately 4,200 feet above mean sea level (MSL). The eastern border of the valley is the north-south trending Oquirrh Mountains, which rise sharply from the valley floor at an elevation of approximately 5,200 feet above MSL to a maximum elevation of 10,350 feet above MSL. The western border of the Tooele Valley is formed by the Stansbury Mountains, which reach a maximum elevation of 11,301 feet above MSL. South Mountain, a relatively low-lying, east-west trending structure, and the Stockton Bar, a Lake Bonneville Pleistocene depositional feature, bound the valley on the south, separating Tooele Valley from Rush Valley. The geographic setting of N TEAD is depicted in Figure 2-1.

3.2.1. Physiography and Topography

3.2.1.1. Physiography. Tooele Valley is situated in the Lake Bonneville Basin of the Basin and Range physiographic province. The Lake Bonneville Basin, typical of Basin and Range physiography, is characterized by alternating, isolated, north-trending, block-faulted mountains and intermontane basins flanked by alluvial slopes.

3.2.1.2. Topography. The topography of the Tooele Valley floor is the result of coalescing alluvial fans that were formed by debris eroded from the Oquirrh and Stansbury mountains. These fans were formed during Pleistocene time when a shallow arm of Lake Bonneville occupied the area, leaving a series of wave-cut benches and gravel bars along the margins of the valley. The most prominent example of such a bar is the Stockton Bar, a low ridge that closes the gap between the Oquirrh Mountains and South Mountain. North Tooele Army Depot is situated on coalescing alluvial fans (a bajada) formed by alluvium eroded from the southern portion of the Oquirrh Mountains.

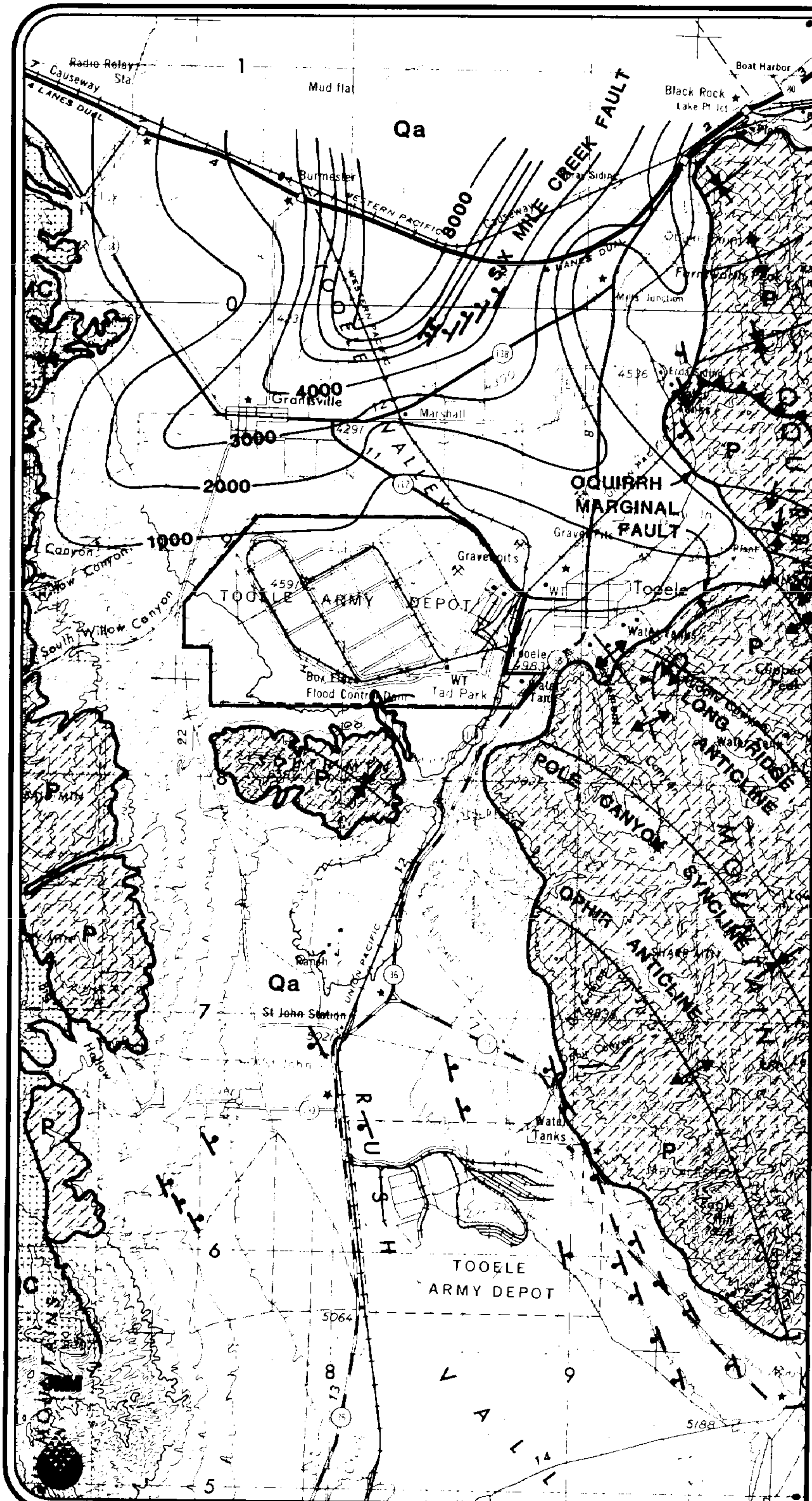
3.2.1.3. The alluvial fans that form the valley floor in the vicinity of N TEAD slope gently toward the north. As shown in Figure 3-1, the N TEAD topography is characterized by a gently rolling surface dissected by a series of shallow gullies. The average topographic gradient in the northern portion of the site is approximately 70 feet per mile, increasing to about 150 feet per mile at the southern boundary.

3.3 GEOLOGY AND SOILS

3.3.0.1. This section describes the regional geologic setting of Tooele Valley. Geologic conditions at N TEAD are similar to those throughout the Tooele Valley. Therefore, the following description of regional geology serves as an introduction to site geology.

3.3.1. Regional Geology

3.3.1.2. The Tooele Valley is bounded by Basin and Range block-faulted mountain on three sides. The Oquirrh Mountains to the east and South Mountain to the south are composed primarily of extensively folded and faulted, alternating beds of quartzite and limestone of late Mississippian, Pennsylvanian, and early Permian age. The composition of the Stansbury Mountains (west side of the Tooele Valley) is similar to that of the Oquirrhs, with the exception of the occurrence of Cambrian quartzite. Gravity surveys and the many faults observed in the valley indicate that the Tooele Valley basin is probably not a single down-faulted structural depression, but is more likely a complex collection of troughs and ridges caused by several down-faulted blocks (ERTEC, 1982). The geology of the region is depicted in Figure 3-1.



EXPLANATION

Qa — Quaternary alluvium

T — Tertiary volcanics

P — Pennsylvanian and Permian sediments

MC — Mississippian through Cambrian sediments

8000 — Estimated thickness of basin fill (feet)

Axis of syncline

Axis of anticline

Overturned anticline

Thrust fault–sawteeth on upper plate

Fault–dot on downthrown side

Adapted from:
Everitt and Kaliser, 1980
Moore and Sorensen, 1978
Tooker and Roberts, 1970

Base map reference:
USGS, Tooele, Utah
1° x 2° Quadrangle, 1970

N

0 1 2 3 4 5
Scale in Miles

GEOLOGIC MAP OF TOOELE VALLEY
FIGURE 3-1

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3.3.1.3. Tooele Valley is filled with a thick sequence of unconsolidated sediments of Tertiary and Quarternary Age. The older Tertiary sediments comprise the Salt Lake Group and consist of moderately consolidated sand, gravel, silt, and clay with an abundance of volcanic ash (Everitt and Kaliser, 1980). The younger Quarternary sediments consist of interlayered and unconsolidated sand, gravel, silt, and clay, including sediments deposited before, during, and after the existence of Lake Bonneville. The thickness of the valley sediments ranges from a few feet at the margins of the valley to over 8,000 feet in the north central part of the valley (Everitt and Kaliser, 1980). The contact between the Tertiary and Quarternary sediments was reported to be between 800 or 900 feet below the ground surface (ERTEC, 1982).

3.3.1.4. The surface of the alluvium has been shaped by inundations of Lake Bonneville. Valley topography shows evidence of wave-cut benches and shoreline erosion. The major lake levels and their dates are as follow (Currey, 1984):

Lake Level	Elevation	Time Period
• Stansbury	4500 feet above MSL	23,000 to 20,000 years ago
• Bonneville	5090 feet above MSL	16,000 to 14,500 years ago
• Provo	4740 feet above MSL	14,500 to 13,500 years ago
• Gilbert	4250 feet above MSL	11,000 to 10,000 years ago.

The elevation of the ground surface in the N TEAD area ranges from about 4,500 feet above MSL at the northern boundary to about 5,200 feet on the western boundary.

3.3.1.5. Bedrock beneath the unconsolidated sediments of the Tooele Valley consists of alternating quartzite and limestone beds similar to the late Paleozoic rocks found in the Stansbury Mountains, Oquirrh Mountains, and South Mountain.

3.3.1.6. Several potentially active faults were identified in the Tooele Valley by Everitt and Kaliser (1980); two of these faults are located near TEAD (Figure 3-1). The Oquirrh marginal fault was observed along the base of the Oquirrh Mountains, just east of the City of Tooele. Evidence of post-Lake Bonneville (less than 18,000 years ago) and post-Holocene displacement (less than 10,000 years ago) was interpreted from fault scarps south of Middle Canyon and northward to Bates Canyon and Lake Point. Post-Holocene movement was also interpreted from scarps along the Six-Mile Creek fault north of Grantsville. These faults are the likely result of Basin and Range tectonism.

3.3.2. Site Geology

3.3.2.1. N TEAD occupies the southern portion of the Tooele Valley. The valley fill consists of silt, sand, gravel, and cobbles composed of quartzite, sandstone, and limestone eroded from the Oquirrh and Stansbury Mountain ranges. Based on previous investigations, geologic conditions beneath N TEAD are similar to those found elsewhere in the Tooele Valley, with unconsolidated alluvial sediments overlying Paleozoic limestone, quartzite, and sandstone formations.

3.3.2.2. Alluvial Deposits. The unconsolidated quartzite, sandstone, and limestone alluvium underlying N TEAD is typical of alluvial fan deposits, consisting of poorly sorted clayey and silty sands, gravels, and cobbles. Lateral changes in the coarseness of the granular sediments are apparent across N TEAD. In general, the sediments on the east and west margins of the Depot are coarse, silty gravels, with some cobbles and boulders. The coarse-grained layers are composed of fine and coarse gravels with varying fractions of sands and cobbles, and they comprise aquifer zones when saturated. By contrast, sediments beneath the central and northern parts of the depot are silts, fine sands, and gravels. Soils are typically yellowish brown to grayish orange with varying amounts of brown, yellow, and orange quartzite and dark gray limestone clasts.

3.3.2.3. Erosion and deposition of the alluvium was influenced by climate, precipitation rates, and periods of inundation by Lake Bonneville. As a result, the alluvial sediments have been reworked, and alluvial units that may have been deposited contemporaneously may not appear to be the same unit. Consequently, lithologic correlation between alluvial units is difficult. However, continuous fine-grained layers (silty clays and clayey silts) have been observed in soil borings at N TEAD (JMM, 1988).

3.3.2.4. Six fine-grained layers have been identified during previous investigations at N TEAD and have been estimated to range from less than 10 feet to more than 70 feet thick. The fine-grained layers are composed of varying fractions of clayey silt, silty clay, and silty, fine to coarse sand. Because the permeability of the fine-grained materials is low, they can act as barriers to groundwater movement. These fine-grained layers are believed to be areally continuous, and result in different hydraulic heads between different water-bearing zones beneath the same location.

3.3.2.5. Evidence of bedding was also identified from seismic refraction surveys conducted by ERTEC (1982). Three distinct velocity layers were identified and interpreted to represent colluvium, uncemented conglomerate, and cemented conglomerate in order of increasing depth. Investigations by JMM (1988) also indicate cemented gravels are present at N TEAD. Samples from deep soil borings revealed cemented gravels at depths greater than 350 feet below ground surface (bgs) beneath the northern portion of N TEAD and north of the N TEAD boundary (JMM, 1988).

3.3.2.6. Although the deeper gravels are believed to be cemented, evidence from drilling indicates that the cement does not completely fill the voids between clasts. Examination of drill cutting samples from the cemented zones revealed that a rind-like calcareous coating exists on the surface of many of the gravel clasts.

3.3.2.7. Bedrock. Little bedrock is exposed at N TEAD. Therefore, existing N TEAD bedrock data are based on investigations at the Industrial Waste Lagoon (IWL) and on geophysical surveys conducted over the entire N TEAD area. The most significant bedrock features are a series of limestone and quartzite outcrops located approximately 1,000 feet north of the IWL area, as depicted in Figure 3-2. Borehole and geophysical data indicate that bedrock in this area occurs as a topographically high, elongated block, oriented northeast to southwest, with deeper suballuvial flanks extending to the southwest and southeast.

3.3.2.8. Bedrock beneath N TEAD consists of brown and gray quartzite and blue-gray and black limestone. Depths to bedrock range from surface outcrops in the northeast corner of N TEAD to more than 2,000 feet bgs in the south-central portion of the facility. The depth to bedrock across N TEAD is shown in Figure 3-2.

3.3.2.9. Tooele Valley has been subjected to many geologic forces throughout history. Laramide folding during the late Cretaceous, Basin and Range faulting during the Miocene and Pliocene, and eastward tilting of the Oquirrh Mountains during the Pliocene and Pleistocene have created multiple fault blocks composed of highly deformed Paleozoic rocks. In addition to the structural deformation, bedrock has been extensively weathered

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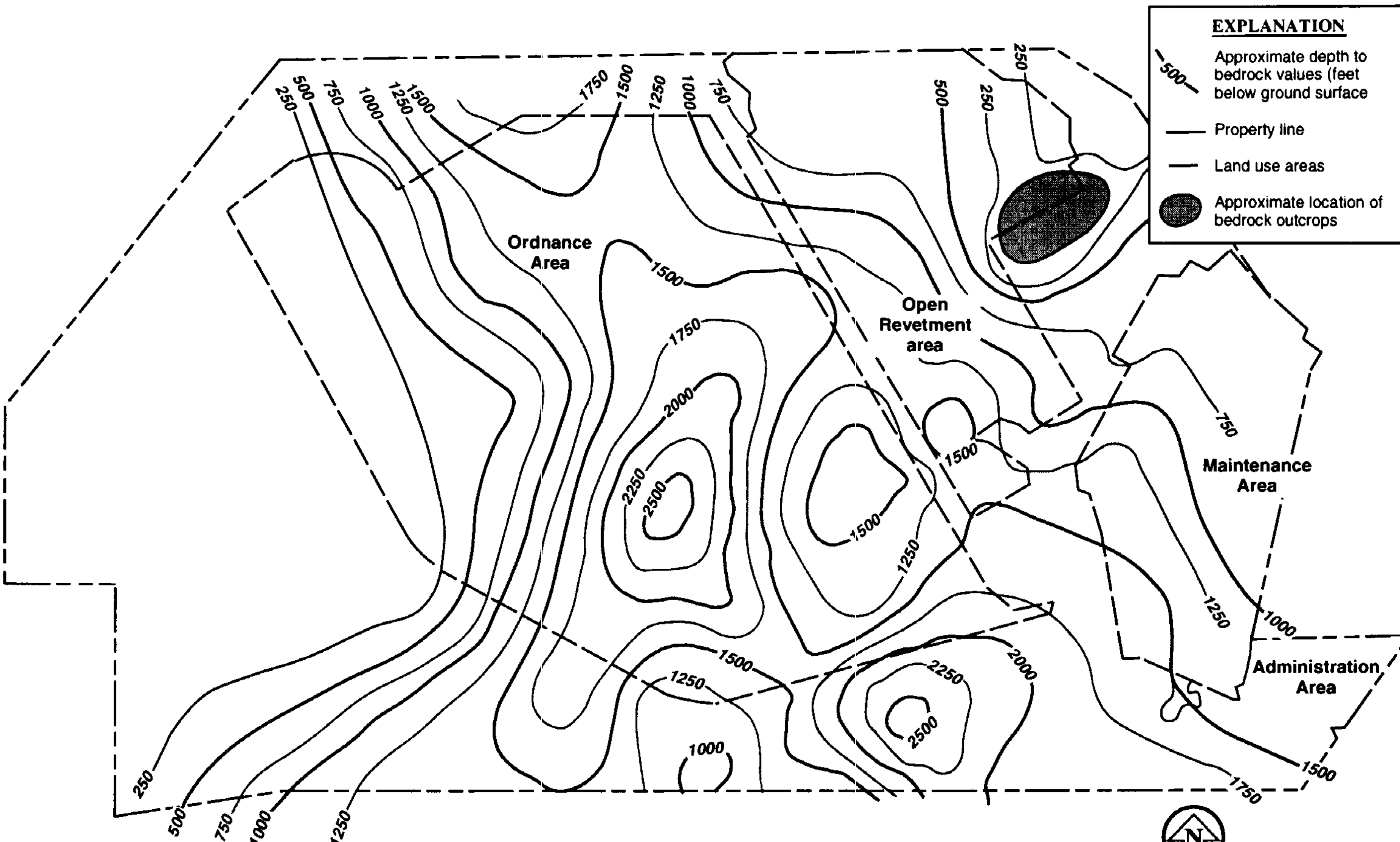


Notes: Depth of bedrock contours based on geophysical survey, ERTEC, 1982;
Bedrock boreholes in the eastern portion of N-TEAD generally confirm geophysical survey.

Source: Office of the Facilities Engineer, Tooele Army Depot, July 1989;ERTEC, 1982

DEPTH TO BEDROCK CONTOUR MAP
FIGURE 3-2

through repeated inundations by Lake Bonneville and silicified and altered by hydrothermal fluids (Tooker and Roberts, 1970).

3.3.2.10. Fractures measured in the bedrock outcrops during previous investigations were generally vertical or near vertical with strikes of about 30° to 50° west of north (JMM, 1988). These directions are approximately perpendicular to the bedding attitudes observed in the outcrops. Evidence of extensive bedrock fracturing was revealed during previous investigations (JMM, 1988). Specifically, the dolomite or argillaceous limestone in the area beneath the IWL and the interbedded sandstone and quartzite at the northwest end of the bedrock block showed evidence of extensive fracturing. Diamond drill cores of these beds revealed zones of open fractures and dissolution cavities that appear to have developed primarily along fracture planes (JMM, 1988). The presence of the open fractures and dissolution zones combined with the uniform groundwater elevations observed in the bedrock body during previous investigations suggest that groundwater conditions in the bedrock are largely controlled by these features (JMM, 1988).

3.3.3. Site Soils

3.3.3.1. Surface soil characteristics in the N TEAD investigation areas reflect the topographic location and the geologic materials from which they were formed. The soils consist primarily of gravelly loam, loam, or fine sand that developed in alluvial deposits or lacustrine sediments. According to unpublished soils maps of the Tooele Valley, the primary surface soils identified at N TEAD consist of the following soil series (USSCS, 1991):

- Abela
- Berent
- Hiko Peak
- Birdow
- Medburn.

3.3.3.2. Soils that develop in semi-arid climates do not develop strong diagnostic horizons. In general, these soils are deep, well-drained, moderately permeable, and alkaline (i.e., pH greater than 7). Water and wind erosion potentials for these soils are considered moderate and slight, respectively. The Abela, Hiko Peak, Birdow, and

Medburn soil series contain inclusions of other soil type. However, the inclusions are either intermingled with the main soil type or their area is aereally too small to map independently. As a consequence, the inclusions are not identified in the major mapping units.

3.3.3.3. The most important difference between the main soil types and the inclusions is texture change (particle size). Soil particle size (percent gravel, sand, silt, and clay) is one of the principal factors determining the chemical and hydraulic properties of soil. Therefore, it is important that all soil types present at the SWMUs are included in the background soil sampling program. Table 3-1 provides a detailed description of the primary soil series and the inclusions found at N TEAD. In addition, the inclusions found in each soil series mapping unit are identified in Table 3-1. A map of the USSCS soil units present at N TEAD is presented in Figure 3-3.

3.4 HYDROLOGY

3.4.1. Climate

3.4.1.1. The climate of the Tooele valley is temperate and semi-arid is characterized by limited precipitation, hot and dry summers, cool springs and falls, and moderately cold winters. The lowest temperatures typically occur in January (monthly mean of 28° F) and the highest temperatures occur in July (monthly mean of 75° F) (EA, 1988). The mean annual air temperature at Tooele from 1941 to 1970 was 51 degrees Fahrenheit. The average growing season (frost free days) is from April 1 through October 25.

3.4.1.2. Because of the location of the continental storm track, most of the precipitation in the Tooele Valley occurs as snow between the months of October and May. Summers are generally dry with occasional thundershowers. May is usually the wettest month, and June through July is the driest period. The greatest amount of precipitation occurs in the adjacent Oquirrh and Stansbury Mountains, where the average annual precipitation is more than 40 inches per year. The average annual precipitation at the City of Tooele for the period from 1897 to 1985 was 16.95 inches. At Grantsville, approximately two miles from N TEAD, the average annual precipitation from 1957 to 1977 was 11 inches (Razem and Steiger, 1981). Gates (1965) estimated that the average annual precipitation that falls on the

TABLE 3-1

GENERAL CHARACTERISTICS OF SURFACE SOIL OF N TEAD INVESTIGATION AREA

Mapping Unit	Soil Type	Origin	General Location	Characteristics: Texture	Depth (Feet BGS)	Soil pH	Permeability	Infiltration Rate (cm/sec)
Abela Included in this unit are Borvant and Birdow soils.	Abela	Developed in alluvium derived primarily from limestone and quartzite.	Alluvial fans on 1 to 8 percent slopes at elevations of 4600 to 6000 feet above MSL.	Gravelly loam (GM-GC; SC-SM)	0 to 0.8	7.9 to 8.4	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam GC-GM)	0 to 1.7	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam to extremely gravelly sandy loam (GM-GC; GP-GM)	1.7 to 5	8.5 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
	Borvant	Developed in alluvium derived predominantly from limestone.	Shallow soil over a carbonate cemented hardpan on fan terraces on short or medium length, convex, 2 to 15 percent slopes at elevations of 5200 to 6500 feet above MSL.	Gravelly loam (GM-GC, SC-SM)	0 to 0.5	7.4 to 9.0	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Very gravelly loam (GM-GC)	0.5 to 1.5	7.9 to 9.0	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Indurated	1.5	...	...	...
Berent-Hiko Peak Complex. Included in this unit are Amtoft, Medburn, Sprager, Taylorsflat, Duneland, and Rock Outcrop soils.	Berent	Eolian sands derived from mixed rock types.	Hummocky vegetated sand dunes and fan terraces up to 30 percent slopes at elevations of 4500 to 5800 feet above MSL.	Loamy fine sand (SM)	0 to 0.5	7.4 to 8.4	Rapid	$4.2x10^{-3}$ to $1.4x10^{-2}$
				Fine sand (SM)	0.5 to 5	7.9 to 9.0	Rapid	greater than $1.4x10^{-2}$
	Hiko Peak	Developed in alluvium from mixed rock types.	Alluvial fan terraces on medium length, convex, 2 to 15 percent slopes at elevations of 4400 to 6000 feet above MSL.	Gravelly loam (GM-GC)	0 to 0.5	7.9 to 8.4	Mod. Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam (GM-GC)	0.5 to 1	7.9 to 9.0	Mod. Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam (GM-GC)	1 to 5	8.5 to 9.0	Mod. Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
	Amtoft	Developed in alluvium derived from mixed rock types.	Rock outcrops on 30 to 70 percent slopes.	Very cobbly loam (GM-GC)	0 to 1	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Extremely cobbly loam (GM-GC; GP-GC))	1 to 1.5	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Unweathered bedrock	1.5	...	...	...
	Spager	Developed in allumium derived from limestone.	Alluvial fan terraces on 2 to 15 percent slopes at elevations of 5200 to 6200 feet above MSL.	Gravelly loam (GM-GC; SC-SM).	0 to 0.5	7.4 to 9.0	Mod Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam, very gravelly fine sandy loam ((GM-GC).	0.5 to 2	greater than 8.4	Mod Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Indurated	2	...	...	-

TABLE 3-1

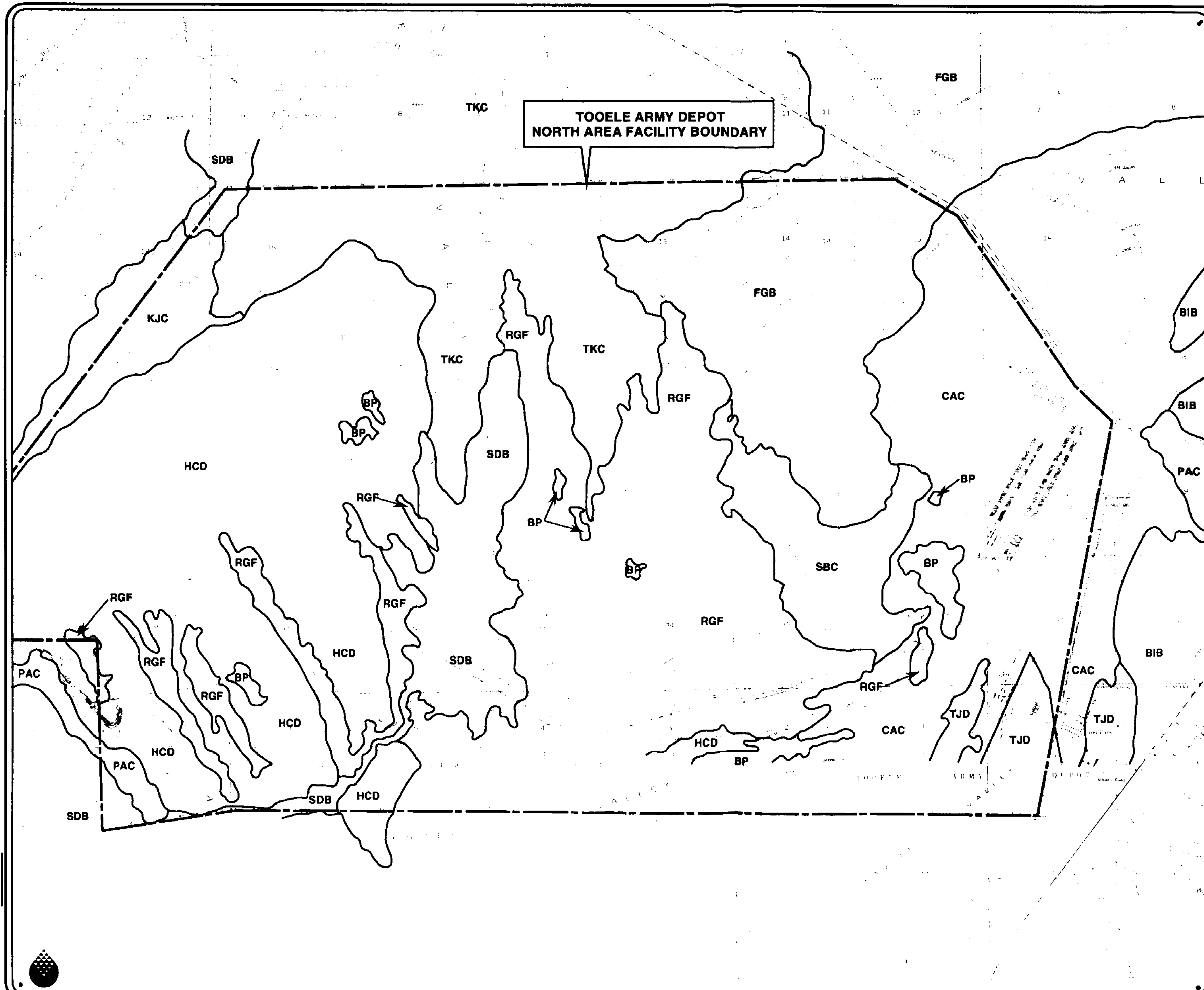
GENERAL CHARACTERISTICS OF SURFACE SOIL OF N TEAD INVESTIGATION AREA
(CONTINUED)

Mapping Unit	Soil Type	Origin	General Location	Characteristics: Texture	Depth (Feet BGS)	Soil pH	Permeability	Infiltration Rate (cm/sec)
	Taylorsflat	Alluvium and lacustrine sediments derived from mixed rock types.	Lake terraces and alluvial fan terraces on medium length, linear to convex, 1 to 5 percent slopes at elevations of 5000 to 6000 feet above MSL.	Loam (CL-ML) Loam (CL-ML) Loam (CL-ML) Loam (CL-ML)	0 to 0.5 0.5 to 1.0 1.0 to 4 4 to 5	7.9 to 8.4 7.9 to 8.4 8.5 to 9.0 8.5 to 9.0	Mod. Slow Mod. Slow Mod. Slow	$4.2x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$
	Duneland	Sand; derived from mixed rock types.	Ridges and intervening troughs made of fine sand sized particles on lake plains and low lake terraces.	Sand (SM-SW)	NA	NA	NA	NA
	Rock outcrop	Dependant on the type of bedrock.	Exposures of barren bedrock that occur mainly on escarpments or ridges. Slopes range from 30 to 60 percent.	NA	NA	NA	NA	NA
Medburn. Included in this unit are Hiko Peak and Taylorsflat soils.	Medburn	Developed in alluvium and lacustrine sediments, derived predominantly from sedimentary rocks.	Lake terraces and alluvial fan terraces on short or medium length, convex or linear, 2 to 8 percent slopes at elevations of 4500 to 5800 feet above MSL.	Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM)	0 to 0.5 0.5 to 3.5 3.5 to 5	7.9 to 8.4 7.9 to 9.0 8.5 to 9.0	Mod. rapid Mod. rapid Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$
Birdow. Included in this unit are Erda and Lakewin soils.	Birdow	Developed in alluvium derived predominantly from limestone and quartzite.	Flood plains, stream terraces, and alluvial fans on long, linear, or slightly concave 1 to 4 percent slopes at elevations from 4250 to 6200 feet above MSL.	Loam (CL-ML) Loam (CL-ML)	0 to 2.3 2.3 to 5	7.4 to 8.4 7.9 to 9.0	Moderate Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$ $4.2x10^{-4}$ to $1.4x10^{-3}$
	Erda	Developed in alluvium and lacustrine sediments derived from mixed rock types.	Alluvial fan terraces and lake terraces on 1 to 5 percent slopes at elevations of 4250 to 6000 feet above MSL.	Silt loam (CL-ML) Silt loam (CL-ML) Silt loam , silty clay loam (CL-ML)	0 to 1 1 to 3 3 to 5	7.4 to 8.4 7.9 to 9.0 7.9 to 9.0	Mod. Slow Mod. Slow Mod. Slow	$1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$

TABLE 3-1

GENERAL CHARACTERISTICS OF SURFACE SOIL OF N TEAD INVESTIGATION AREA (CONTINUED)

Mapping Unit	Soil Type	Origin	General Location	Characteristics: Texture	Depth (Feet BGS)	Soil pH	Permeability	Infiltration Rate (cm/sec)
	Taylorsflat	Alluvium and lacustrine sediments derived from mixed rock types.	Lake terraces and alluvial fan terraces on medium length, linear to convex, 1 to 5 percent slopes at elevations of 5000 to 6000 feet above MSL.	Loam (CL-ML) Loam (CL-ML) Loam (CL-ML) Loam (CL-ML)	0 to 0.5 0.5 to 1.0 1.0 to 4 4 to 5	7.9 to 8.4 7.9 to 8.4 8.5 to 9.0 8.5 to 9.0	Mod. Slow Mod. Slow Mod. Slow	$4.2x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$ $1.4x10^{-4}$ to $1.4x10^{-3}$
	Duneland	Sand; derived from mixed rock types.	Ridges and intervening troughs made of fine sand sized particles on lake plains and low lake terraces.	Sand (SM-SW)	NA	NA	NA	NA
	Rock outcrop	Dependant on the type of bedrock.	Exposures of barren bedrock that occur mainly on escarpments or ridges. Slopes range from 30 to 60 percent.	NA	NA	NA	NA	NA
Medburn. Included in this unit are Hiko Peak and Taylorsflat soils.	Medburn	Developed in alluvium and lacustrine sediments, derived predominantly from sedimentary rocks.	Lake terraces and alluvial fan terraces on short or medium length, convex or linear, 2 to 8 percent slopes at elevations of 4500 to 5800 feet above MSL.	Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM) Fine sandy loam (SM; SC-SM)	0 to 0.5 0.5 to 3.5 3.5 to 5	7.9 to 8.4 7.9 to 9.0 8.5 to 9.0	Mod. rapid Mod. rapid Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$ $1.4x10^{-3}$ to $4.2x10^{-3}$
Birdow. Included in this unit are Erda and Lakewin soils.	Birdow	Developed in alluvium derived predominantly from limestone and quartzite.	Flood plains, stream terraces, and alluvial fans on long, linear, or slightly concave 1 to 4 percent slopes at elevations from 4250 to 6200 feet above MSL.	Loam (CL-ML) Loam (CL-ML)	0 to 2.3 2.3 to 5	7.4 to 8.4 7.9 to 9.0	Moderate Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$ $4.2x10^{-4}$ to $1.4x10^{-3}$
	Erda	Developed in alluvium and lacustrine sediments derived from mixed rock types.	Alluvial fan terraces and lake terraces on 1 to 5 percent slopes at elevations of 4250 to 6000 feet above MSL.	Silt loam (CL-ML) Silt loam (CL-ML) Silt loam, silty clay loam (CL-ML)	0 to 1 1 to 3 3 to 5	7.4 to 8.4 7.9 to 9.0 7.9 to 9.0	Mod. Slow Mod. Slow Mod. Slow	$1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$ $1.4x10^{-4}$ to $4.2x10^{-4}$



EXPLANATION

BP	Borrow Pits
BIB	Lakewin Series
CAC	Abela Series
FGB	Manessa Series
HCD	Hiko Peak Series
KJC	Hiko Peak — Taylorsflat Complex Series
PAC	Birdow Series
RGF	Berent — Hiko Peak Complex Series
SBC	Medburn Series
SDB	Medburn Saline Series
TJD	Doyce Series
TKC	Taylorsflat Series

Source: USSCS, 1991

0 4000
Scale in Feet

N TEAD
SOIL TYPE MAP
FIGURE 3-3

PROJECT NO. 2942.0120

valley and the mountain precipitation contributed by tributaries to the valley is approximately 200,000 acre-ft.

3.4.1.3. Classical sea breeze circulation exists in the in the Salt Lake Basin, which includes the Tooele Valley (EA, 1988). The predominant wind directions in the Tooele valley, south to north and north to south, are caused by diurnal temperature changes. As the surface temperature of the land increases during the day, (compared to the temperature of the lake) the winds generally blow upslope, from north to south, into the valley and mountains. As the land temperature cools (compared to the temperature of the lake) during the night, the wind direction reverses and moves downslope toward the lake, from south to north.

3.4.2. Surface Water Hydrology

3.4.2.1. There are five perennial streams in the Tooele Valley, with a total discharge of approximately 17,000 acre-feet of water per year (Razem and Steiger, 1981). These streams originate in the mountains above the Tooele Valley in response to rapid snowmelt and summer thunderstorms. Two streams originate in the central Oquirrh Mountains at the eastern side of the valley and enter the valley near Tooele and the other three originate in the central Stansbury mountains on the western side of the valley.

3.4.2.2. No perennial streams exist at N TEAD; although the western border is cut by the drainages from South Willow and Box Elder Canyons. South Willow Creek, near the northwest boundary of N TEAD, is the largest stream in the Tooele Valley with an annual flow of approximately 4,830 acre feet. Box Elder Wash, in the southwest portion of N TEAD (south to north), is an intermittent stream that has an annual discharge of approximately 900 acre feet. Except during rare periods of heavy rain or rapidly melting mountain snowpacks, surface water flow from South Willow drainage or Box Elder drainage does not occur at N TEAD. The surface water from these drainages are either diverted for irrigation shortly before or after they leave the canyons or the waters infiltrate directly into the unconsolidated deposits near the mountain fronts.

3.4.2.3. Artificial drainage systems have been constructed at N TEAD to control storm runoff. These systems terminate in spreading areas or in natural drainage channels. Near the industrial area, surface water runoff is to the west and southwest until it reaches the central part of the valley, and then it flows in a more northwesterly direction. Runoff from the area near the former wastewater ditches flows to the west for a few hundred yards and then follows a northwesterly route.

3.4.2.4. Evapotranspiration. A large portion of precipitation in the Tooele Valley is transpired by plants and evaporated from soils. Gates (1965) reported a potential annual evapotranspiration rate of 40,000 acre feet in the Tooele Valley. Potential evapotranspiration exceeds precipitation in every month except November, December, and January, leaving about 10 percent of the annual precipitation as potential recharge (JMM, 1988). A more detailed investigation by Razem and Steiger (1981) indicated that evapotranspiration is approximately 23,000 acre feet per year.

3.5 HYDROGEOLOGY

3.5.1. Regional Hydrogeology

3.5.1.1. Most of the groundwater in the Tooele Valley occurs in the valley fill deposits and to a lesser extent in the underlying bedrock. Because the valley fill deposits are generally coarse-grained, they form a productive aquifer system when saturated. Although little is known about the water-bearing characteristics of the bedrock aquifer, it is important to the Tooele Valley hydrogeologic system because it serves as a source of underflow to the alluvial valley fill along the margins of the Tooele Valley (JMM, 1988).

3.5.1.2. The alluvial aquifer is primarily composed of gravels with major interbeds consisting of varying amounts of sands, silts, and clays. Although the gravels vary in composition, they generally consist of quartzite fragments with minor limestone, sandstone, and igneous fragments. The alluvium ranges in thickness from zero feet at the basin margin to over 8000 feet in the north central part of Tooele Valley (Everitt and Kaliser, 1980). At the northern TEAD boundary, the alluvium thickness is approximately 780 feet (EA, 1988).

3.5.1.3. The bedrock aquifer consists primarily of quartzite and limestone of low primary permeability. However, secondary permeability can be relatively high locally, owing to the presence of fractures and solution openings in the bedrock (JMM, 1988).

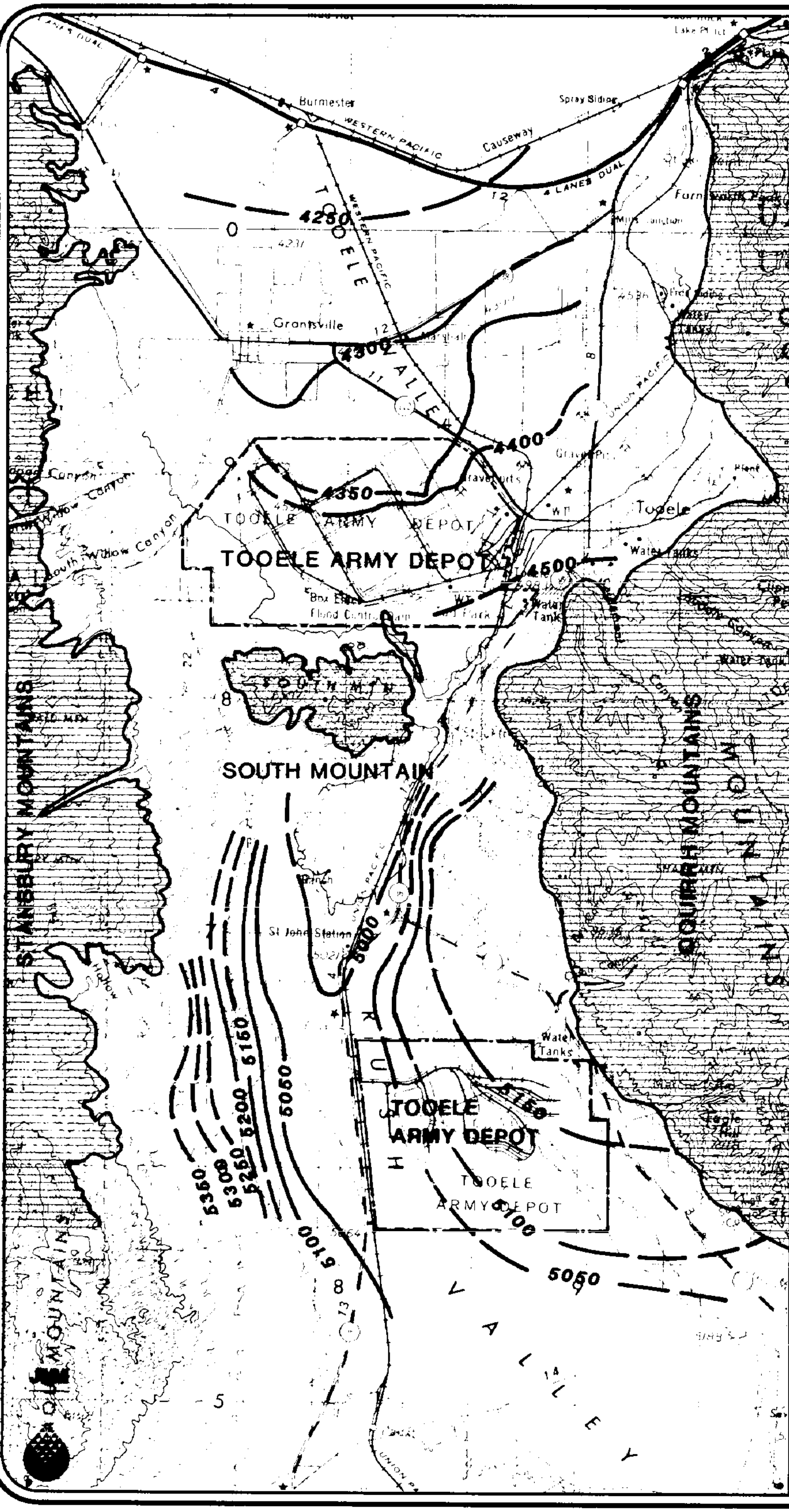
3.5.1.4. Groundwater conditions vary throughout the Tooele Valley; water table (unconfined), confined, and artesian conditions have been encountered. The depth to groundwater ranges from less than 10 feet bgs in northern Tooele Valley (near the Great Salt Lake) to more than 700 feet bgs along the southwestern edge of N TEAD.

5.5.1.5. Regionally, groundwater originates at recharge areas along the basin margins and moves inward toward the center of the Tooele Valley. Groundwater flows northward toward the Great Salt Lake and ascends to discharge areas in the northern parts of the valley. Recharge zones along the valley margins and upper reaches of the valley are characterized by downward vertical gradients. Major discharge areas exist north of N TEAD in the Tooele Valley (e.g., Six-Mile Spring and Fishing Creek Spring). Piezometers and monitoring wells installed near the northern N TEAD boundary revealed upward vertical gradients in that area (JMM, 1988). Figure 3-4 shows the regional groundwater contours in the Tooele and Rush Valleys.

3.5.2 Site Hydrogeology

3.5.2.1. The aquifer system in the N TEAD area is composed of bedrock overlain by an extensive alluvial aquifer. The bedrock aquifer occurs beneath a relatively small area of N TEAD, while the remainder of N TEAD and the Tooele Valley is directly underlain by the alluvial aquifer. While both the alluvial and bedrock aquifers have unique hydraulic characteristics, they readily communicate groundwater and are, therefore, considered to comprise a single aquifer system (JMM, 1988).

3.5.2.2. **Alluvial Aquifer.** The alluvial aquifer consists of saturated alluvium and lacustrine sediments composed primarily of gravels, with major interbeds of varying amounts of sands, silts, and clays. The alluvial aquifer ranges in thickness from zero at the bedrock block outcrops north of the IWL area to more than 750 feet near the northern boundary of N TEAD. Although the alluvial aquifer contains alternating discontinuous layers of fine- and coarse-grained sediments, it is considered to be a single aquifer system because no confining layers have been identified from investigations conducted at the southern end of the Tooele Valley. However, the contrast between the hydraulic conductivities of the fine-grained and coarse-grained layers is sufficient to maintain different hydraulic heads between layers beneath the northern area of the Tooele Valley (JMM, 1988).



EXPLANATION

Mountains

Ground-water surface contour line, dashed where inferred (5000)

Adapted from:
Everitt and Kaliser, 1980
Moore and Sorensen, 1978
Tooker and Roberts, 1970

Base map reference:
USGS, Tooele, Utah
1° x 2° Quadrangle, 1970

0 1 2 3 4 5

Scale in Miles

REGIONAL GROUNDWATER CONTOURS IN TOOELE AND RUSH VALLEY
FIGURE 3-4

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3.5.2.3. Groundwater flow enters N TEAD from the southeast, south, and southwest and converges beneath the central part of the site. The general direction of groundwater flow beneath N TEAD is from the south to north. Throughout the southern portion of N TEAD, groundwater flow patterns are influenced by downward hydraulic gradients. In contrast, at the northern boundary, the vertical gradients are upward, indicating convergence of flow from deeper parts of the aquifer in this area. In general, the potentiometric surface is relatively flat across N TEAD, with a hydraulic gradient of approximately 0.007 foot per foot (ft/ft). However, in the vicinity of the bedrock block, the hydraulic gradient steepens and the flow pattern is considerably altered.

3.5.2.4. The average horizontal hydraulic conductivity of the alluvial aquifer is approximately 1,500 gallons per day per square foot (gpd/ft ^{2}) or 7.1 x 10^{-2} centimeters per second (cm/s), whereas the average vertical hydraulic conductivity is approximately 225 gpd/ft ^{2} (1.1 x 10^{-2} cm/s). Because of the heterogeneity of the alluvium aquifer, calculated groundwater velocities range from about 4 feet per year (ft/yr) to greater than 9,800 ft/yr (JMM, 1988). Based on the vertical hydraulic conductivity values, the average calculated vertical groundwater velocity ranges from less than 1 ft/yr to 200 ft/year (JMM, 1988). The average porosity of the alluvial aquifer was estimated to be 25 percent.

3.5.2.5. Bedrock Aquifer. The bedrock aquifer, consisting primarily of low permeability quartzite and limestone, occurs beneath a relatively small area in the eastern portion of N TEAD. Although permeability of the bedrock is generally low, strong evidence suggests extensive fracturing in the bedrock allows for considerable groundwater flow (JMM, 1988). Highly fractured or weathered bedrock yield the highest hydraulic conductivities, while unfractured bedrock and fractured bedrock with clay-filled, silicified or calcified fractures have the lowest hydraulic conductivities. With the exception of the IWL area, there is little information regarding the bedrock aquifer at N TEAD. The hydraulic conductivity of the quartzite bedrock is estimated at 2,000 gpd/ft ^{2}. Where the bedrock contains clay-filled fractures, the hydraulic conductivity is estimated to be two gpd/ft^2. The hydraulic gradients in the bedrock block range from 0.02 to 0.09 ft/ft. The horizontal velocity of groundwater in the bedrock block ranges from less than 10 ft/yr to about 5,500 ft/yr. The average porosity of the bedrock is estimated to be 3 percent.

3.5.3. Groundwater Characteristics

3.5.3.1. Sixty-two monitoring wells were installed at N TEAD as part of a Groundwater Quality Assessment at the IWL (JMM, 1988). These wells and other existing monitoring wells and water supply wells are also shown in Figure 3-5. A groundwater surface elevation contour map for N TEAD is also shown in Figure 3-5. This map was created from groundwater elevation measurements collected in 1987.

3.5.3.2. Groundwater elevations have been measured at N TEAD since about 1982. The groundwater surface in the alluvial aquifer is characterized by relatively flat gradients, except in the vicinity of the bedrock block, where gradients steepen considerably. Groundwater elevations in each of the flat areas have been found to vary about ten feet or less. A relatively flat groundwater surface is normally indicative of a uniform hydraulic conductivity within an aquifer. In general, the shape of the alluvial aquifer groundwater surface reflects the paleotopography of the now buried depositional surface. The configuration of the bedrock aquifer indicates that the bedrock block readily transmits groundwater and maintains a very uniform groundwater surface elevation. Historical water level data indicate that water levels rose in response to record high precipitation in Utah between 1982 and 1984 (JMM, 1988). Water levels peaked near the end of 1986 and have gradually declined as precipitation rates have decreased to normal or below normal levels. Hydrographs presented in the *Final Ground-Water Quality Assessment Engineering Report to the Tooele Army Depot, Utah* (JMM, 1988) and water elevation measurements in the *Groundwater Quality Assessment for Tooele Army Depot, Tooele Utah* (ESE, 1991) depict the changes in alluvial and bedrock water table elevations in response to decreased precipitation.

3.5.3.3. Previous investigations also show that localized perched water tables exist beneath two sites (i.e., TNT Washout Facility and Sanitary Landfill) at N TEAD. In these areas, perched water tables have been shown to vary in depth from approximately 17 to 180 feet bgs. Previous reports indicate that groundwater perched along these zones will eventually reach the regional alluvial aquifer (WESTON, 1990)

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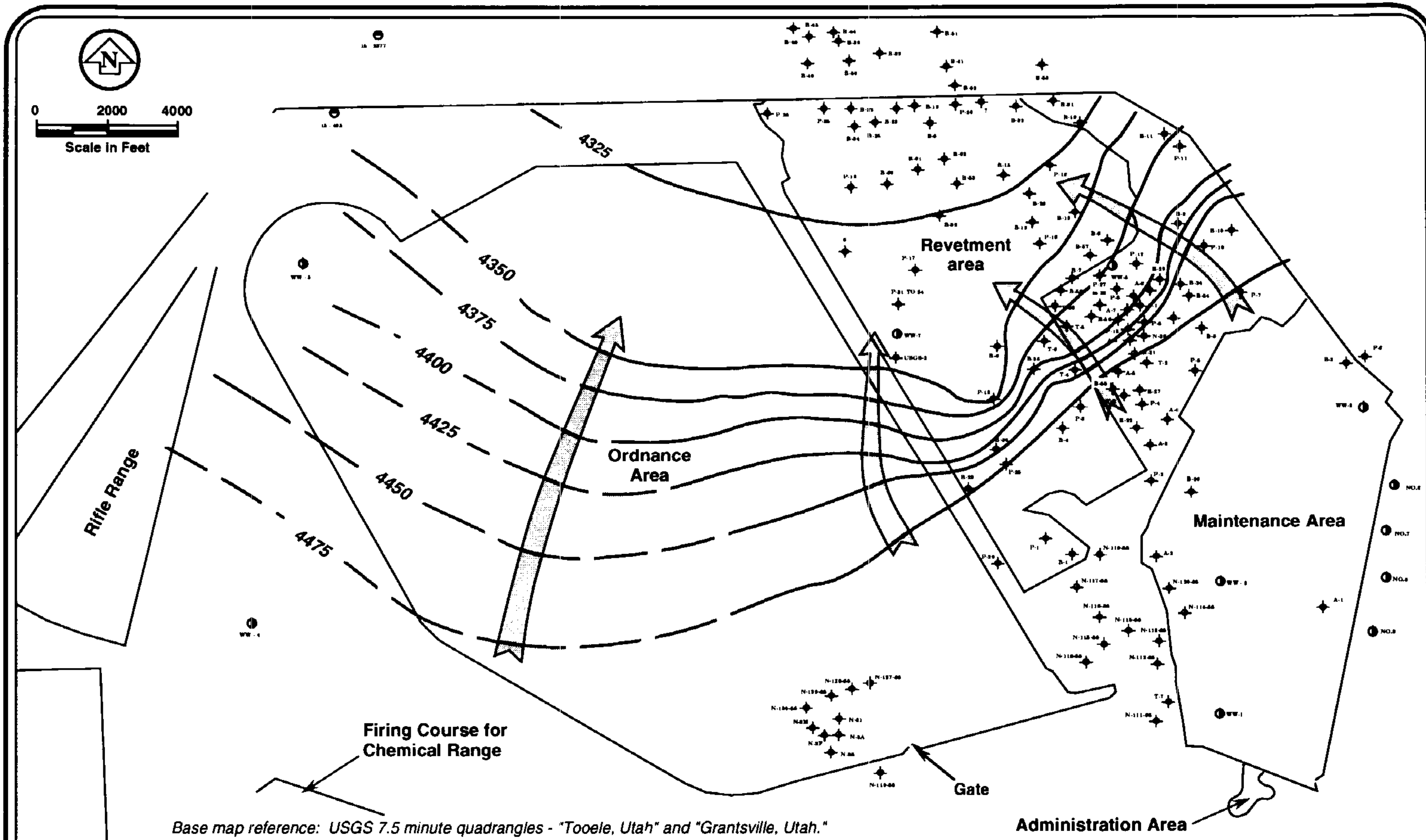


Base map reference: USGS 7.5 minute quadrangles - "Tooele, Utah" and "Grantsville, Utah."

EXPLANATION

- Existing monitoring wells and Piezometers
- Municipal and N TEAD water supply wells
- Private Wells
- Interpretive groundwater flow direction
- Groundwater contour (feet, MSL) dashed where inferred.

JMM

N TEAD GROUNDWATER WELL AND GROUNDWATER ELEVATION CONTOUR MAP

FIGURE 3-5

3.5.4. Aquifer Chemistry and Groundwater Use

3.5.4.1. Groundwater Chemistry. Based on extensive water quality analyses, JMM identified three major, naturally occurring groundwater types at N TEAD (Types 1, 2, and 3), which were differentiated from each other based on the concentrations of major ions (e.g., calcium, magnesium, potassium, sulfate, chloride, nitrate, fluoride and bicarbonate (JMM, 1988). These three water types are generally found in specific geographic areas across N TEAD, although overlap occurs.

3.5.4.2. Type 1 groundwater occurs generally within the alluvial and bedrock aquifers on the eastern and western portions of the site and reflects the influence of mixing with recharge waters from the mountains. Type 1 groundwater is characterized as a bicarbonate water (does not contain dominant cations or anions) that is typical of groundwater in recharge areas. In addition, sodium concentrations are lower with respect to chloride compared to other groundwater types.

3.5.4.3. Type 2 groundwater reflects the influence of mixing with more saline water from the bedrock aquifer and from underflow from Rush Valley and occurs in the northern, southern, and central portions of N TEAD. It is characterized by higher concentrations of all major ions, specifically chloride and sodium, than Type 1 groundwater.

3.5.4.4. Type 3 groundwater occurs in the alluvial aquifer north of the N TEAD boundary, beneath the off-depot area that was investigated by JMM (1988). Type 3 groundwater is characterized by the highest concentrations of sodium and chloride, calcium, and sulfate. Type 3 groundwater mixes with geothermal waters to the north of N TEAD and is considered geothermal groundwater.

3.5.4.5. Groundwater Use. Water supply wells at N TEAD are used intermittently. Data collected in 1981 indicate that water use at N TEAD was 325,296,000 gallons. During 1981, domestic water use at N TEAD accounted for approximately 17 percent of total water usage, and industrial use accounted for the remainder. Approximately 40 percent of total annual discharge from the Tooele Valley groundwater system is to wells, with the remaining discharge attributed to springs, evapotranspiration, and underflow to the Great Salt Lake. Previous reports estimate that N TEAD usage accounts for only 4 percent of water use within Tooele Valley (JMM, 1988).

3.5.4.6. Several large irrigation and livestock supply wells are located north of N TEAD. These irrigation and stock wells are pumped in the summer months and may affect the groundwater flow system near N TEAD during this period (WCC, 1986).

3.5.5. Groundwater Contaminant Plume

3.5.5.1. Under the terms of a Consent Decree (Civil C85-C-1080G) filed January 13, 1986, in the U.S. District Court for the District of Utah, Central Division, the state of Utah required TEAD to conduct a groundwater quality assessment in the area of the IWL. The IWL consisted of an unlined evaporation lagoon and several unlined ditches that carried wastewater for approximately 1.5 miles from outfalls in the Maintenance Area to the lagoon. From approximately 1965 to 1988, the IWL received wastewater from maintenance operations, including metal cleaning and stripping, steam cleaning, sand blasting, boiler plants, dynamometer test cells, spillage leaks, overflow containing oils, solvents, paints, and photographic chemicals (ERTEC, 1982). The purpose of the groundwater quality assessment was to define the extent and magnitude of groundwater contaminated by industrial wastewater leaking from the IWL.

3.5.5.2. Groundwater flow directions in the vicinity of the IWL are generally to the northwest. As trichloroethylene-contaminated groundwater entered the bedrock underlying the IWL, the contaminant migration was controlled by hydraulic conductivities in the bedrock (i.e., extent and amount of fracturing) and downward vertical gradients. Data from monitoring wells indicate that trichloroethylene concentrations are generally higher within the bedrock than in the alluvium immediately adjacent to the bedrock surface. Therefore, the bedrock appears to act as a conduit for the contaminants until lateral groundwater flow from the bedrock carries them into the adjacent alluvium.

3.5.5.3. Vertical gradients also influenced the shape of the trichloroethylene plume. Downward seepage beneath the IWL ditches carried the contaminants into the bedrock. Upward gradients near the northern N TEAD boundary carried contaminants to shallower depths, effectively limiting the depth of trichloroethylene in off-depot groundwater.

3.6 ECOLOGY

3.6.0.1. The objectives of this section are to identify the plant and animal species that are found in the N TEAD area and to identify threatened or endangered plant and animal species that may use N TEAD. The following sections discuss the vegetation, wildlife habitats, and animal species found in the N TEAD area.

3.6.1. Flora

3.6.1.1. Climate and soil types are the most important factors determining which plant communities will be found at N TEAD. In general, N TEAD is undeveloped rangeland and can be classified as an Artemesia Biome. The dominant plant types in this biome are sagebrush (Artemesia) and saltbrush (Artiplex). Because the climate is relatively constant, this general classification can be subdivided into smaller groups based on vegetation and soil types. The plant types found at N TEAD consist of native, introduced, and ornamental species. In this section, the major soil types found at N TEAD will be used to discuss the occurrence of flora at N TEAD; however, the occurrence of ornamental species will not be discussed. No endangered plant species have been identified at N TEAD.

3.6.1.2. Abela Soils. The dominant plant species currently found in conjunction with Abela soils are mountain big sagebrush, rabbitbrush, snakeweed, yellowbrush, cheatgrass, and bluebunch wheatgrass. The potential plant community in this mapping unit is about 50 percent perennial grasses, 10 percent forbs, and 40 percent shrubs. Plant species considered important for human or wildlife use in this unit are bluebunch wheatgrass, bluegrass, mountain big sagebrush, and antelope bitterbrush (USSCS, 1991).

3.6.1.3. Hiko Peak Soils. The dominant plant species currently found most often in conjunction with the Hiko Peak soils are Wyoming big sagebrush, Douglas rabbitbrush, Indian ricegrass, and cheatgrass. The potential plant community is approximately 45 percent perennial grasses, 15 percent forbs, and 40 percent shrubs. Plant species considered important for human or wildlife use in this soil mapping unit are Wyoming big sagebrush, bluebunch wheatgrass, and Indian ricegrass (USSCS, 1991).

3.6.1.4. Medburn Soils. The dominant plant species currently found in conjunction with the Medburn soils are black greasewood, shadscale, bottlebrush, squirreltail, spiny horsebrush, and seepweed. The potential plant community for this soil mapping unit is approximately 30 percent perennial grasses, 15 percent forbs, and 55 percent shrubs. Plant species considered important for human or wildlife use are black greasewood, Wyoming big sagebrush, bottlebrush, squirreltail, and Indian ricegrass (USSCS, 1991).

3.6.1.5. Birdow Soils. The dominant plant species found to occur in conjunction with the Birdow soils are basin big sagebrush, bluebunch wheatgrass, rabbitbrush, and basin wildrye. The potential plant community for this soil mapping unit is about 70 percent perennial grasses, 10 percent forbs, and 20 percent shrubs. Plant species considered important for human or wildlife use are basin wildrye, western wheatgrass, and basin big sagebrush (USSCS, 1991).

3.6.1.6. Berent Soils. The vegetation currently found in conjunction with the Berent soils is Utah juniper, Wyoming big sagebrush, needleandthread, and cheatgrass. The potential plant community on this soil mapping unit is an overstory of Utah juniper with about 30 percent cover. Understory vegetation is about 45 percent perennial grasses, 20 percent forbs, and 35 percent shrubs. Important plant species for human and wildlife use are needleandthread, Indian ricegrass, and fourwing saltbush (USSCS, 1991).

3.6.2. Fauna

3.6.2.1. N TEAD is inhabited by a variety of animals, including large and small mammals, insects, birds, amphibians, snakes, and lizards. Some of the more common residents include mule deer, black-tailed jack rabbits, desert cottontail rabbits, coyotes, burrowing owls, horned larks, meadowlarks, and western kingbirds. In addition, migrating waterfowl use flyways that cross N TEAD. A complete listing of the animal species found in the N TEAD area, is included in the *Installation Environmental Assessment, Tooele Army Depot, North and South Area, Tooele, Utah Report* (IPEC, 1982).

3.6.2.2. Currently, there are two endangered species, the bald eagle and the peregrine falcon, that may use the N TEAD area. Bald eagles from northern latitudes hunt along streams and lakes throughout Utah and winter in the Rush Valley, south of N TEAD. Peregrine falcons have been reintroduced in the marshes along the Great Salt Lake and near Timpie Springs Wildlife Management Area in the northern end of the Stansbury Mountains. Both species may be visitors to the N TEAD area. The ferruginous hawk Swainson's hawk, and longbilled curlew which are listed as federal and state candidate endangered species, use the N TEAD area (1991). No other threatened or endangered animal species have been identified in the N TEAD area.

3.7 DEMOGRAPHY/LAND USE

3.7.0.1. Tooele Valley is predominantly undeveloped, with the exceptions of the cities of Grantsville (1991 population 4,500), and Tooele (1991 population 13,887) and occasional residential developments north of Tooele City. The current population of Tooele County is 26,601 (Tooele, 1991) Grantsville is approximately 2 miles north of the northwest corner of N TEAD while Tooele is next to the northeast corner of the Depot. Livestock grazing and limited cultivation predominate in the valley.

3.7.0.2. Except for the City of Tooele, properties immediately adjacent to N TEAD boundaries are undeveloped. Properties to the north are used for pasture or cultivation; properties to the west and south are used for rangeland grazing. Properties east of N TEAD consist of a combination of residential portions of Tooele and undeveloped rangeland along the lower western slopes of the Oquirrh Mountains. Several gravel pits are also located southeast of N TEAD along SR 36. Except for the southeastern portion (bounded by SR 36), N TEAD is bounded on the east by the Union Pacific Railroad right-of-way. The Tooele Municipal Airport and scattered residential homes are located along the eastern boundary north to SR 112, which forms the northeastern boundary of N TEAD. The area northeast of SR 112 is undeveloped except for a construction company and Tooele County Landfill.

4.0 FIELD INVESTIGATIONS

4.1 INTRODUCTION

4.1.0.1. The purpose of the Phase I field investigation is to collect the data that is required to meet the N TEAD RFI objectives. This section contains a summary of the data objectives, the sampling rationale, and the field investigation programs that will be used to implement the Phase I RFI at N TEAD. Field investigations are planned for 15 of the 20 SWMUs listed in Task Order 4. The following SWMUs were selected for the field investigation based on the Scope of Work outlined in Task Order 4, the initial site visit, and interviews with current and former TEAD personnel familiar with the operational histories of the SWMUs:

- SWMU-1 Open Burning/Open Detonation Areas
- SWMU-4 Sandblast Areas
- SWMU-14 Sewage Lagoons
- SWMU-19 AED Demilitarization Test Facility
- SWMU-20 AED Deactivation Furnace Site
- SWMU-21 AED Deactivation Furnace Building
- SWMU-26 DRMO Storage Area
- SWMU-29 Drum Storage Areas
- SWMU-34 Pesticide Handling and Storage Area
- SWMU-37 Contaminated Waste Processing Plant
- SWMU-38 Industrial Waste Treatment Plant
- SWMU-42 Bomb Wash Out Building
- SWMU-45 Stormwater Discharge Area
- SWMU-46 Used Oil Dumpsters
- SWMU-47 Boiler Blowdown Water.

SWMU-27, SWMU-28, SWMU-39, SWMU-43, and SWMU-44 were not included in the field investigation because previous site activities, facility design, and current management practices indicate little potential for contaminant release. Refer to Section 2.0 for a complete site description and history for each SWMU.

4.1.0.2. In addition to the field investigations at the listed SWMUs, three facility-wide programs, the background soil investigation, groundwater elevation survey, and field survey, will be conducted at N TEAD. The background soil investigation program will be used to develop a data base of inorganic and anion concentrations which represent the conditions in background soils at N TEAD. Comparisons of inorganic and anion concentrations from the SWMU-specific soil investigations with those of the background soils will be made using analysis of variance (ANOVA). The results of these statistical comparisons will be included in the Phase I RFI report. The groundwater elevation survey will generate facility-wide water level contour maps for the Phase I RFI report. The field survey will be performed to provide location information for data entry and storage in the USATHAMA Installation Restoration Data Management Information System data base. The remainder of this section, as outlined below, provides a detailed discussion of the sampling rationale for each SWMU and the field procedures for each sampling effort and facility-wide investigation:

- Introduction to the field investigation program (schedule, preparatory field activities, and record keeping)

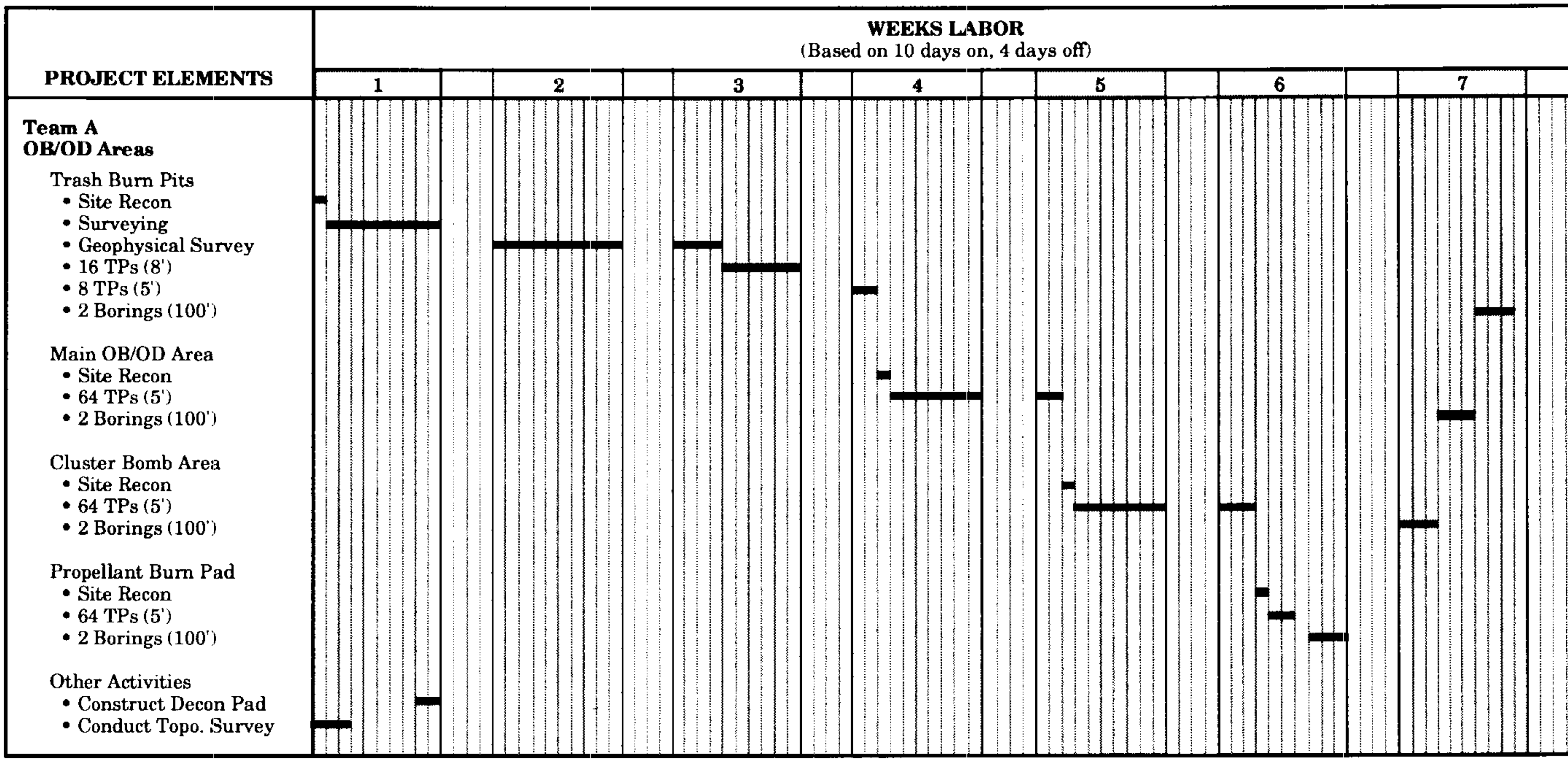
- SWMU specific investigations

- Field investigation procedures

- Facility-wide investigations.

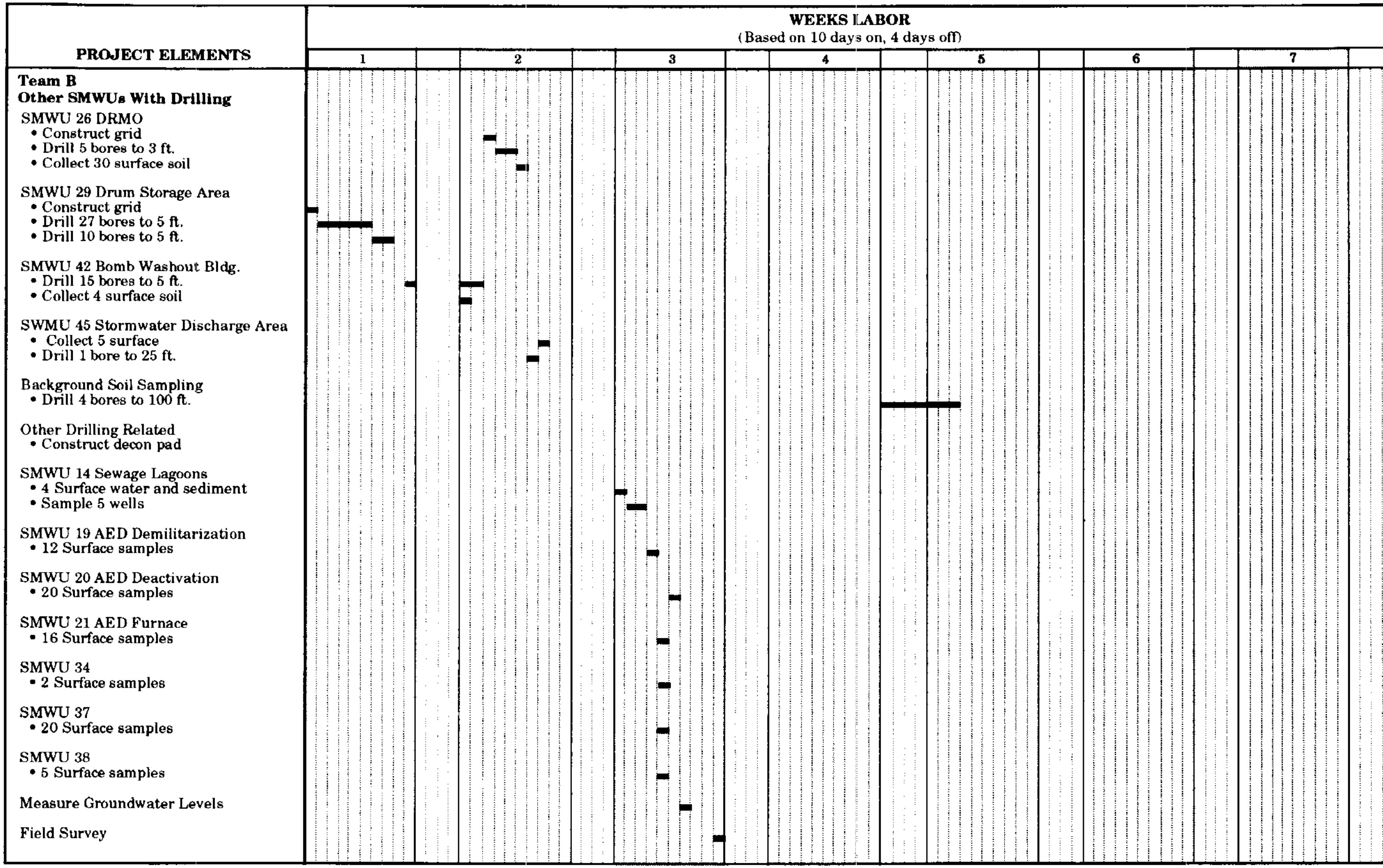
4.1.1. Schedule and Personnel

4.1.1.1. The field investigations will be conducted during the late spring and summer of 1992. While the actual start date has not been finalized, JMM believes that inclement or cold weather could seriously impact the success of the field sampling programs. For this reason, initiation of field investigations will be dependent upon weather conditions and will likely begin during May or early June after late spring rain and cold temperatures have abated. Figure 4-1 presents a preliminary schedule for the field investigation program.



FIELD ACTIVITIES SCHEDULE—TEAM A FOR N TEAD RFI

FIGURE 4-1a



JMM

FIELD ACTIVITIES SCHEDULE—TEAM B FOR N TEAD RFI

FIGURE 4-1b

4.1.1.2. To meet the schedule, JMM will provide five full-time field personnel including a full-time field operations leader/site safety officer and two sampling teams of two people each (Teams A and B). As depicted in Figure 4-1, one of the two sampling teams will be devoted to conducting the investigations in the OB/OD areas (SWMU-1), while the other sampling team will complete the activities at the other SWMUs.

4.1.2. Preparatory Activities

4.1.2.1. Before initiating field work, a series of preparatory activities will be completed to help insure the efficient operation of each field investigation program. These include:

- Establishing a clean water source according to USATHAMA procedures
- Obtaining site access (badges and vehicle permits) for the field team members
- Conducting orientation meetings that include discussions of fire control and other N TEAD safety requirements
- Establishing a support facility that includes an office trailer, restroom facilities, and on-site communications (cellular phones)
- Obtaining utility clearance and excavation permits for all exploration test pit and soil boring locations
- Conducting a field survey to establish reference locations at each SWMU where samples will be collected
- Setting up a staging area for subcontractor equipment and material storage
- Constructing a decontamination pad where drilling and sampling equipment will be steam cleaned.

Each of these preparatory activities is discussed in detail below.

4.1.2.2. Clean Water Source. The first preparatory field activity will be to sample and analyze a source of nonchlorinated, nontreated clean water to be used in all field activities and for decontamination operations. Because N TEAD water supply well WW-1, is located upgradient from all known contaminant sources, it has been selected as the clean water source. Duplicate unfiltered groundwater samples will be collected from this well approximately two months before initiation of field activities. These samples will be analyzed for target compound list VOCs, SVOCs, metals, explosives, PCBs and pesticides, petroleum hydrocarbons, and selected anions.

4.1.2.3. N TEAD Access. Access procedures have been established by N TEAD and they will be followed by all JMM and subcontractor personnel. Access to N TEAD is restricted through two main entrances: the main access gate, which is south of Tooele, and the east gate, which is east of Tooele. Access through these gates is controlled by N TEAD security. All JMM and subcontractor personnel will request access to TEAD through the Environmental Management Office (EMO) which will contact security prior to on-site arrival. The current contact at the N TEAD EMO is Mr. Larry Fisher. Mr. Fisher will require the names and social security numbers of all JMM and subcontractor personnel and vehicle license plate numbers and proof of current registration before requesting personnel badges and vehicle passes from the security office. Any personnel who are not U.S. citizens must be granted permission by the Depot commander (i.e., Form 3840) for site access. The N TEAD security office also requires the serial numbers of all recording equipment such as cameras and tape recorders and will issue permits for their on-site use.

4.1.2.4. Although no field programs are planned for the ammunition area, several wells included in the groundwater level measurement sampling program are located there. Additional site access and operating procedures are required for the ammunition area and are listed below.

- No flame-producing devices (e.g., lighters and matches), firearms, alcoholic beverages, and photographic equipment (unless preauthorized through N TEAD security) will be taken into the ammunition area by JMM personnel or subcontractors.

- All vehicles that pass through the ammunition security checkpoint will undergo a vehicle inspection and have a portable fire extinguisher.

- All JMM and subcontractor personnel, vehicles, and equipment in the ammunition area will be subject to search at any time by N TEAD security.

4.1.2.5. Field Team Orientation. One week before the field work begins, members of the field team will undergo a general site orientation. This will include an overview of the project, discussions of potential problems, and a review of N TEAD fire control and safety requirements. Details of these subjects are included in Appendix A of the Project Health and Safety Plan (HASP).

4.1.2.6. USATHAMA Geotechnical Requirements. USATHAMA has developed geotechnical requirements for drilling, monitoring well construction, data acquisition, and report preparation. These requirements, which are included as Appendix A to this document, were used as guidelines for developing the procedures for sampling soils, sediment, groundwater, and surface water. All field team members will be required to read the USATHAMA geotechnical requirements presented in Appendix A of this document before conducting on-site activities and to have a copy of this DCQAP in their possession during the field work.

4.1.2.7. Support Facilities. One of the first field activities will be establishing a support facility which includes an office trailer, restroom facilities, and cellular phone communication. The office trailer will consist of a 10-foot by 44-foot mobile trailer placed in either the administration or maintenance areas at a location approved by N TEAD. N TEAD will provide connection for electrical power for the office trailer. The trailer will remain on site throughout the duration of the field program (approximately four months). In addition to the office trailer, a Port-O-Potty will be set up at the same location as the office trailer. A subcontractor will supply and service the Port-O-Potty facility and require site access on a weekly basis. Throughout the field program, three cellular telephones will be used for on-site and off-site communications. Both the field operations leader/site safety officer and both sampling crews will be equipped with cellular telephones.

4.1.2.8. Utility Clearance and Excavation Permits. All sites where drilling or test pit excavation is planned will be cleared for underground utilities prior to any field work by N TEAD personnel. N TEAD requires an excavation permit for all subsurface investigations. The permit will be prepared by JMM with assistance from the EMO and the N TEAD facility engineer.

4.1.2.9. Topographic Field Survey. Geotechnical map data for the USATHAMA IRDMIS database will be obtained from each SWMU included in the field sampling program (excluding SWMU-46 and SWMU-47) by surveying at least one reference location before field sampling is conducted. At each sampling location, the surveyed reference location will be used to determine the state plane coordinates for each sampling location. A more extensive discussion of the topographic field survey is included in Section 4.3 of this document. A complete discussion of the IRDMIS sample location requirements is included in the *Project Data Management Plan* (DMP).

4.1.2.10. Equipment Staging Areas. To provide adequate space for subcontractor equipment storage, a small equipment staging area will be needed at the same general location as the JMM office trailer (in the Administration or Maintenance Areas) and also in the vicinity of the OB/OD Areas (at the southwest corner of the Depot). Soil sampling activities in the Administration and Maintenance Areas are generally limited to the top several feet of soil. For this reason, the amount of equipment needed to drill to those depths will not require a large storage area. However, sufficient area to park a tandem axle truck and trailer and stage several dozen 55-gallon drums will be needed. Similarly, in the OB/OD Areas, the equipment staging area will need to accommodate several large trucks and trailers and also allow room to stage several dozen 55-gallon drums.

4.1.2.11. Decontamination Pad. The decontamination pad will be constructed in the OB/OD equipment staging area from flexible 40-mil thick high-density polyethylene. The polyethylene will be set over a sloping sand base that drains to a sump at one end. The pad will be large enough to accommodate the largest on-site vehicle that could require decontamination. Decontamination will be conducted using a high-pressure steam/hot water cleaner. Decontamination water that collects in the sump will be pumped to 55-gallon drums for storage and eventual disposal. Discussions of equipment decontamination and waste handling procedures are included in Section 4.3.

4.1.3. Documentation and Record Keeping

4.1.3.1. Proper documentation and record keeping of all activities performed at N TEAD will be kept throughout the duration of the Phase I RFI field investigation. Records will be kept on activity specific forms in 3-ring bound notebooks and in individual field notebooks that consist of hard-bound surveyors type field books.

4.1.3.2. Site Log Book. A site log book will be kept at the field operations office. Information concerning daily operations and any changes to the CDQAP during the field program will be recorded daily in the site log book (e.g., on-site personnel, weather conditions, and work completed). Copies of the site log books will be included as an appendix to the Phase I RFI Report. The field operations leader/on-site safety officer will be responsible for completing the site log book. An example of the site log book form is included in Figure 4-2.

4.1.3.3. Field Books. Each member of the field investigation team will be issued a bound, surveyor type field book. All field entries will be made in ink. Corrections will be made by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the change. The field team members will be responsible for entering logs of daily activities in these field books. Types of information entered will include:

- Equipment calibration records
- Field parameter observations
- Date/time of sample collection
- Water levels
- Start times
- Location of sampling times
- Weather conditions
- Description of deviations from sampling plans
- Personnel present
- Visitors
- Depth of sample
- Sample descriptions

DAILY FIELD LOG

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

DAILY FIELD REPORT NUMBER : ____________

PROJECT ______________________________ DATE ______________________________

JOB NO. ______________________________ DAY ______________________________

CLIENT ______________________________ WEATHER CONDITIONS ______________

CONTRACTOR(s) ____

LOCATION ____

VISITORS ON SITE ____

EQUIPMENT ON SITE ____

SUMMARY OF ACTIVITIES ____

FIELD CHANGES LOG ____

PAYABLE QUANTITIES ____

JMM REPRESENTATIVE ______________________ DATE ______________________

CONTRACTORS' REPRESENTATIVE ______________ DATE ______________________

JMM FIELD SUPERVISOR ____________________ DATE ______________________

JMM

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N TEAD RFI PAGE _____ OF _____ FIGURE 4-2

- Sample designations
- General observations.

4.1.3.4. Activity-Specific Forms. In addition to the general record keeping described in the proceeding paragraphs, a series of activity-specific forms will be used to document specific field activities. These include:

- Test Pit Excavation Log (Figure 4-3)
- Soil Boring Log (Figure 4-4)
- Groundwater Sampling Log (Figure 4-5)
- Chain of Custody Forms (Appendix B)

Additional activity-specific forms for sample handling, labeling, and other information are included in Section 6.0 of this document.

4.1.3.5. In addition to the written documentation, a photographic record of each field activity will be made. Test pit excavations will be photographed with a placard indicating the test pit designation prior to backfilling. Soil boring and surface soil sampling locations at each SWMU will also be photographed. Photographs will be taken of the geophysical survey, groundwater sampling, and other activities. Selected photographs which are illustrative of the various field investigation programs will be included in the Phase I RFI reports.

4.2 SWMU-SPECIFIC INVESTIGATIONS

4.2.1. Overview

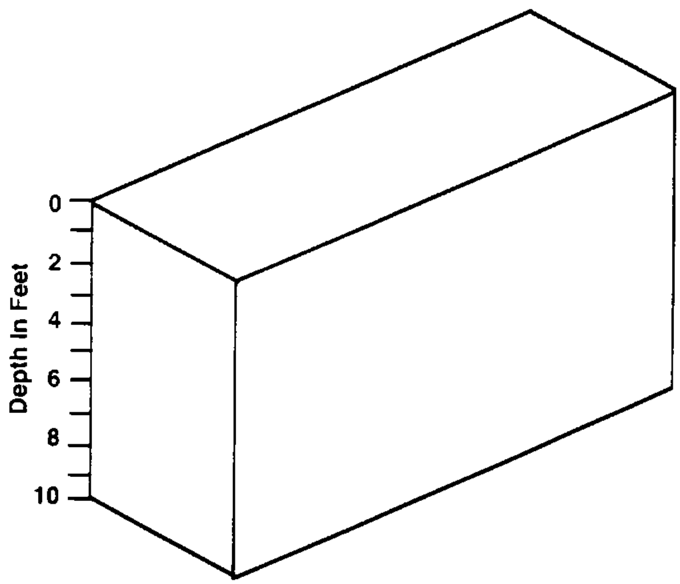
4.2.1.1. This section discusses the RFI data objectives and sampling rationale for each of the 15 SWMUs included in the field investigation and identifies the technical approach (field programs) that will be used to meet the RFI objectives. This information is also summarized in Table 4-1. A summary of all the samples that are to be collected during this RFI is provided in Appendix C.

4.2.1.2. The type of data required to meet the RFI objectives is SWMU specific, and is dependent on the materials that were handled and the past and present operations at each

TEST PIT EXCAVATION LOG
James M. Montgomery, Consulting Engineers, Inc.

TEST PIT LOG: TP ____
DATE EXCAVATED: ____
TIME EXCAVATION BEGAN: ____
WEATHER CONDITIONS: ____
LOCATION OF TEST PIT REFERENCE POINT: ____

Feet N,S ____
Feet E,W ____
of Survey Ref. ____



Orientation =
Total Depth =
Length =

SAMPLE NO.	SAMPLE LOCATION (ft.)	USCS SOIL TYPE	SOIL DESCRIPTIONS	HNU READINGS

Comment:

JMM

N TEAD RFI

FIGURE 4-3

PROJECT NO. 2942.0120

SOIL BORING LOG

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

BORING NO.

PAGE OF

LOCATION of Soil Borings

Feet N.S. ____
Feet E.W ____
of Survey Ret. ____

LOG SHEET NUMBER (Bore/page no.) ____
GEOLOGIST ____
DATE ____
DRILLING CONTRACTOR ____
DRILL RIG ____
BORING DIAMETER ____
TYPE OF SAMPLE ____

FLUID LEVEL				DATE STARTED
TIME				
DATE				DATE FINISHED
HOLE DEPTH				

SAMPLE INTERVALS	BLOWS PER 6 IN.	USCS SYMBOL	MUNSELL COLOR	%GRAVEL GRAVEL	%SAND	%FINES	GRAPHIC LOG	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	FID/PID READING OR COMMENT
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		

JMM

N TEAD RFI

FIGURE 4-4

PROJECT NO. 2942.0120

GROUNDWATER SURFACE WATER SAMPLING LOG
James M. Montgomery, Consulting Engineers, Inc.

Sample Location__________ Surface Water/Groundwater______________ Log Number __________
(Use: Well name/Log number)

Sampling Personnel________________ Date ______________ Weather____________________

MEASUREMENT SUMMARY:

Calculated Purge Volume___________ gallons Total Depth____________ Borehole Diameter__________

Depth to water_______________ Time________________ Measuring point________________

Final pH___________________ Final SC______________ Final Temp(°C)_________________

SAMPLING SUMMARY:

Casing evacuated with: Dedicated Pump _______ Portable Submersible Pump ________ Bailer__________

Pump Started_______ Pump Stopped_______ Total gallons______ Individual Sample Container_______

Time	pH	SC	Temp	Flow rate (gpm)	Comments

INSTRUMENTATION: pH Meter: Orion ☐ Cole-Parmer ☐ Calibration Buffers: 4 ☐ 7 ☐ 10 ☐

Specific Conductivity Meter: Markson ☐ YSI ☐ Standard Solution ______umhos/cm

SAMPLES COLLECTED AND TIME: Filtered Metals______Pesticides_____Herbicides______Cyanide_______

VOCS___________Dioxins/Furans______________Nitrate/Nitrate and Phosphate_______________

SVOCS______________TRPH______________ Anions_______________Explosives______________

PROJECT NO. 2942.0120

FIGURE 4-5

TABLE 4-1

SWMU-SPECIFIC FIELD PROGRAM SUMMARY

SWMU Number	Site Name	Sampling Objective	Program Scope	Rationale
1 1a 1d	Main Demolition Area Cluster Bomb Detonation Area Propellant Burn Pans	Evaluate whether OB/OD activities have released metals, anions, or explosives to the soils	• Identify OB/OD locations through field observations and aerial photo interpretation	Identify areas with potential for maximum contamination
			• Excavate 125 test pits to approximately five feet. Collect two soil samples per pit (250 total)	Collect soil samples from areas with potential for maximum contamination and from other areas to define aerial extent
			• Drill and sample five soil borings to a depth of 100 feet. Collect seven samples per boring (35 total)	Collect soil samples from areas where potential for surface water infiltration may be turning contaminants toward the regional water table
1b 1c	Propellant Burn Pad Trash Burn Pits	Evaluate whether OB activities have released metals, anions, or explosives to the soils	• Identify OB locations through field observations and aerial photo interpretation	Identify areas with potential for maximum contamination
			• Confirm OB locations through terrain conductivity and geomagnetic geophysical surveys	Verify OB locations
			• Excavate 30 test pits to depths of five to eight feet. Collect two samples per pit (60 total)	Collect soil samples from old burn/disposal pits to see if residue or debris is releasing contamination
			• Drill and sample three soil borings to a depth of 100 feet. Collect seven samples per boring (21 total)	
	Box Elder Wash	Determine if OB/OD activities have released metals, anions, or explosives to the surface soils in Box Elder Wash	• Collect six surface soil samples from locations along Box Elder Wash where it enters the Depot, passes through the OB/OD area, and leaves the area	Assess potential impacts the OB/OD activities may have on surface water

TABLE 4-1

SWMU-SPECIFIC FIELD PROGRAM SUMMARY
(CONTINUED)

SWMU Number	Site Name	Sampling Objective	Program Scope	Rationale
4	Sandblast Areas	Determine if sandblast media is a source of metals, VOCs, or SVOCs in the nearby soils and surface water pathways	• Collect up to six samples of nearby surface soils	Determine presence of absence of contaminants from sandblast media
14	Sewage Lagoons	Determine whether sewage lagoons are a source of VOCs, SVOCs, metals, or TRPH in the underlying soils and groundwater	• Collect two samples of water and sediment from the active lagoon. Collect two rounds of groundwater samples from five wells	Compare water quality in the lagoon with upgradient, crossgradient, and downgradient groundwater quality
19	AED Demilitarization Test Facility	Determine if this SWMU is a source of metals, SVOCs, or explosives in surface soils	• Collect 12 surface soil samples from around the buildings and test areas	Determine presence or absence of contaminants from tests at the facility
20	AED Deactivation Furnace Site	Determine if this SWMU has released metals to the surrounding surface soils	• Collect 20 surface soil samples from around the edges of the paved areas	Determine presence or absence of contaminants from demilitarization tests at the facility
21	Deactivation Furnace Building	Determine if the deactivation furnace has released metals, SVOCs, and dioxins to the surrounding surface soils	• Collect 16 surface soil samples from around the edges of the paved areas	Determine presence or absence of contaminants from demilitarization activities at the facility
26	DRMO Storage Yard	Determine if salvage and storage activities have released metals, VOCs, or SVOCs to the surface and shallow sub-surface soils	• Establish a sampling grid across the site	Use grid to provide areal coverage
			• Collect 45 surface soil samples from stained areas and from other randomly located sample locations in the sampling grid spaces	Examine surface soils in areas suspected of receiving contamination

TABLE 4-1

SWMU-SPECIFIC FIELD PROGRAM SUMMARY (CONTINUED)

SWMU Number	Site Name	Sampling Objective	Program Scope	Rationale
			• Drill to three feet at each location	Examine subsurface soils to evaluate whether filling and grading at the site has covered contaminated soils
			• Collect 15 soil samples from three feet from areas suspected of having subsurface contamination	Examine suspected contaminated subsurface soils
27	RCRA Container Storage Area	No sampling planned	NA	This SWMU has adequate protection against releases and there is no evidence of a release
28	90-Day Drum Storage Area	No sampling planned	NA	This SWMU has adequate protection against releases, and activities follow proper waste management practices (Jordan, 1990)
29(a)	Drum Storage Areas	Determine if past drum storage practices have released metals, VOCs, SVOCs, pesticides, or TPHCs	• Establish a sampling grid in areas where drums were reportedly stored	Use grid to provide areal coverage
			• Randomly locate 27 borings to five feet in the sampling grid spaces	Examine surface and shallow soils for contaminants
			• Collect two soil samples per bore (54 total)	Examine surface and shallow soils for contaminants due to surface water transport/infiltration
			• Locate 10 borings to five feet in lowlying areas where surface water run-off may have ponded. Collect two samples per boring (20 total)	

TABLE 4-1

SWMU-SPECIFIC FIELD PROGRAM SUMMARY
(CONTINUED)

SWMU Number	Site Name	Sampling Objective	Program Scope	Rationale
34	Pesticide Handling and Storage Area	Determine if surface soils around this facility have received metal, pesticide, or herbicide contamination	• Collect four surface soil samples from beneath gravel around handling/batching areas	Determine if pesticide handling and mixing has released contaminants to the nearby soils
			• Collect one surface soil sample from beneath gravel below outfall drain pipe	Determine if wash water from the handling/batching area has released contaminants to soils at discharge point
37	Contaminated Waste Processor	Determine if metal, SVOCs, or dioxins have been released by this furnace	• Collect 20 surface soil samples from around the edges of the paved areas	Examine nearby soils for presence or absence of contaminants
38	Industrial Waste Treatment Plant	Determine if residual metals, VOCs, or SVOCs remain in surface soils which received windblown GAC	• Collect four surface soil samples from areas known to have received GAC	Examine soils for presence or absence of contaminants
			• Collect one sample of GAC from Storage Container	Examine GAC for types of contaminants
39	Solvent Recovery Facility	No sampling planned	NA	This SWMU has adequate protection against releases, and activities follow proper waste management practices
42	Bomb Washout Building	Determine if metals or explosives were released by burning and washout activities	• Drill 14 borings to five feet along washout water discharge areas	Determine presence of absence of contaminants in surface and shallow soils
			• Collect two samples per borehole (28 total)	
			• Collect four surface soil samples from around the building	Examine surface soils around building for indication of contaminants from airborn releases

TABLE 4-1

SWMU-SPECIFIC FIELD PROGRAM SUMMARY
(CONTINUED)

SWMU Number	Site Name	Sampling Objective	Program Scope	Rationale
			• Collect two surface soil samples from site of a second furnace	Examine site of second furnace for presence or absence of contaminants
43	Container Storage for P999	No sampling planned	NA	This SWMU never actually received polished chemical agent-contaminated rocket components
44	Tank Storage for TCE	No sampling planned	NA	TCE tank that contained F-listed wastes was cleaned, removed from the building, and turned in for salvage
45	Stormwater Discharge Area	Determine if surface water discharges are a source of metals, VOCs, SVOCs, explosives, pesticides, and TRPH in this area	• Collect five surface water samples	Examine whether current discharges carry contaminants
			• Collect five sediment samples	Examine whether contaminants are present in the sediment
			• Drill one borehole to 25 feet and collect seven soil samples	Determine if infiltrating surface water is carrying contaminants toward regional water table
46	Used Oil Dumpsters	Determine if the dumpsters are a source of TRPH in shallow underlying soils	• Collect up to 46 soil samples from surface soils and a one foot from around the used oil dumpsters and from surface water runoff locations	Examine if dumpsters have released contamination to nearby soils
47	Boiler Blowdown Water	Determine if discharges of boiler blowdown water are a source of metals, VOCs, or SVOCs to soils	• Collect six samples of surface water and sediment from discharge areas	Examine if boiler blowdown water is releasing contamination to underlying soils

SWMU. One or more of the following sampling programs will be conducted at each SWMU to meet the data objectives of the RFI:

- Surface soil sampling
- Sub-surface soil sampling
- Groundwater sampling
- Surface water sampling
- Sediment sampling.

4.2.1.3. Both judgmental and random sampling procedures will be used to determine where surface and/or subsurface soil samples will be collected. When following judgmental sampling procedures, field personnel determine the actual sample locations. This technique will be used for surface soil, subsurface soil, and sediment sampling locations. Criteria for selecting sample locations will include obvious signs of contamination (i.e., ground staining) and areas where contaminant accumulation would be expected (i.e., high use areas).

4.2.1.4. Random sampling procedures will be used only in conjunction with sampling grids for determining surface and near-surface soil sampling locations. This technique will be employed at two of the SWMUs (SWMUs-26 and -29) included in the investigations. Random numbers will be generated to identify the sampling location within a grid space. The type of procedure that will be used during soil sampling is SWMU-specific and is discussed in more detail in the following portions of Section 4.2. Detailed descriptions of field sampling procedures are included in Section 4.3.

4.2.2. Open Burning/Open Detonation Areas (SWMU-1, -1a, -1b, -1c, -1d)

4.2.2.1. SWMU-1 consists of five separate subareas where hazardous materials have been treated or disposed of. These include:

- Main Demolition Area (SWMU-1)
- Cluster Bomb Detonation Area (SWMU-1a)
- Propellant Burn Pad (SWMU-1b)
- Trash Burn Pits (SWMU-1c)
- Propellant Burn Pans (SWMU-1d)

The first four of these subunits were identified by previous investigations and included in the RI work plans prepared by E.C. Jordan (Jordan, 1990b). Since the preparation of those work plans, a fifth subarea (the Propellant Burn Pans) has been added to SWMU-1. All five of these subareas are included in the field investigations of the OB/OD Areas.

4.2.2.2. Data Requirements. Based on a review of available information regarding the OB/OD areas, the following data are necessary to satisfy the objectives of the Phase I RFI:

- Confirm the locations of the Cluster Bomb Detonation Area (SWMU-1a) and Propellent Burn Pad (SWMU-1b)

- Estimate the areal distribution of contaminants in the Main Demolition Area (SWMU-1), the Trash Burn Pits (SWMU-1c), and the Propellant Burn Pans (SWMU-1d).

- Quantify contaminant source concentrations at each of the subareas within the OB/OD areas.

- Estimate the vertical distribution of contaminants in soils at each of the subareas

- Assess the potential for contaminant transport by surface water flow in Box Elder Wash where it passes through the OB/OD areas.

4.2.2.3. Technical Approach. To satisfy the data requirements, sample locations in the OB/OD areas will be determined judgmentally. A series of investigative techniques will be used to support this approach. These include:

- Interpretation of historical burial photographs

- Conducting ground truthing activities (field observations) to confirm locations of OB/OD sites

- Clearing unexploded ordnance (UXO)

- Geophysical surveying
- Excavating and sampling of test pits
- Drilling and sampling deep soil borings to 100 feet
- Collecting shallow surface soil samples

4.2.2.4. Main Demolition Area (SWMU-1), Cluster Bomb Detonation Area (SWMU-1a), and Propellant Burn Pans (SWMU-1d). Because the Main Demolition Area, Cluster Bomb Detonation Area, and Propellant Burn Pan Areas are located near each other in SWMU-1, these areas will be investigated by the same program. Analysis of historical aerial photographs indicates the presence of many trenches in the Main Demolition Area which are now obscured by more recent site activities. The aerial photographs also indicate the presence of numerous craters in portions of the Main Demolition Area and Cluster Bomb Detonation Area. Since the Propellant Burn Pan Area is relatively new, this subarea does not appear in any of the historical aerial photographs. Based on the aerial photographs, areas of past activity will be located in the field by ground truthing. After the potential source areas are identified, 125 test pits (approximately 2 x 8 x 5 feet) will be excavated and sampled in the areas of historical activity as well as in areas that are currently active. Test pits will be located to provide general coverage of conditions within the three subareas. Test pits will be located to examine the nature of contaminants in potential source areas and around the outside perimeter of these areas to investigate the areal extent of contamination. A total of two soil samples will be collected from each test pit (250 total). All samples will be analyzed for target compound list (TCL) explosives, metals, and anions, and eight samples will be selected for explosive reactivity tests. Sample collection criteria are discussed in Section 4.3.3.

4.2.2.5. In addition to the test pits, a total of five 100-foot soil borings will be drilled and sampled in these three subarea to evaluate vertical contaminant migration. These borings will be located where there is a potential for downward contaminant migration in the vicinity of contamination source areas and where infiltration of surface water runoff may act to transport contaminants. These borings will be located to provide general coverage of the three subareas. Three of the deep borings will be located in the Main Demolition Area while one each will be located in the Cluster Bomb Detonation and Propellant Burn Pan Areas. Specific drilling and sampling methods are discussed in Subsections 4.3 of this document. A total of seven soil samples will be collected from each boring (35 total). The sample collection intervals will be spaced so the entire length of the borehole is represented. Sample collection criteria are discussed in Sections 4.3.3. and 4.3.4. All samples will be analyzed for explosives, metals, and anions, and five samples will be selected for explosive reactivity testing.

4.2.2.6. Propellant Burn Pad (SWMU-1b) and Trash Burn Pits (SWMU-1c). Since SWMU-1b and SWMU-1c are located in the same vicinity, the field investigation program will be conducted to cover both areas. This program, which is similar to that at the other OB/OD areas, will consist of the following elements:

- Analyze historical aerial photographs to identify the locations of burial pits and other areas of activity
- Develop a detailed composite aerial photograph-based map that indicates each burial area
- Conduct a field survey to locate each burial area as indicated by the composite map
- Confirm burial area locations through geomagnetic and terrain conductivity geophysical surveys
- Excavate and sample 30 test pits in burial areas which are potential sources of contamination
- Drill and sample three 100-foot deep soil borings through potential source areas.

4.2.2.7. Locations of old burial sites and other areas of activity in the Propellant Burn Pad and Trash Burn Pit areas will be located using a slightly different approach than at the other OB/OD areas. A detailed composite aerial photograph-based map will be developed for use in conjunction with field surveying techniques to locate old burial pits and trenches. Because of distortions in the historical aerial photos, computerized rectification of photoimages will be necessary for development of an accurate base map. Once the rectified base map is developed and survey reference points verified in the field, field survey methods will be used to locate the old burial pits and trenches. Both geomagnetics and terrain conductivity geophysical surveys will be used to confirm the locations and determine the areal extent of the old burial areas. The geophysical survey methods are presented in Section 4.3.2.

4.2.2.8. A total of 30 test pits (approximately 2 x 8 feet) ranging from 5 to 8 feet deep will be excavated through the old burial areas to examine the nature of buried materials. Test pit locations will be based on the results of the rectified base map and geophysical surveys. Two soil samples will be collected from each test pit (60 total) and all samples will be analyzed for explosives, metals, and anions. Eight samples will be selected for explosive reactivity analysis. Soil sample collection criteria are presented in Section 4.3.3.

4.2.2.9. Three 100-foot deep soil borings will be drilled in the Propellant Burn Pad and Trash Burn Pit Areas, to evaluate vertical contaminant migration. Because these areas are within a southward-sloping valley, the deep soil borings will be located along the center of the valley. One soil boring will be positioned at the head of the valley where the Propellant Burn Pad was located, the second soil boring will be drilled near the mid-point of the valley where historic aerial photographs indicate the presence of a large burial pit, and the third soil boring will be located near the base of the valley in the vicinity of the Trash Burn Pits. A total of seven soil samples will be collected from each soil boring (21 total). The sample collection intervals will be determined by the field personnel and will be spaced so the entire length of the borehole is represented. Sample collection criteria is presented in Sections 4.3.3. and 4.3.4. All samples will be submitted for analysis of explosives, metals, and anions, and three samples will be selected for explosive reactivity testing.

4.2.2.10. Box Elder Wash. To evaluate whether the OB/OD activities in the southwest corner of TEAD have released contaminants that may be transported by surface water in Box Elder Wash, six surface soil samples will be collected from this drainage. These samples will be taken at the following locations:

- At two tributary locations where Box Elder Wash enters N TEAD
- At the confluence of these two tributaries adjacent to the Main Demolition Area and the Propellant Burn Pan Area
- At a location adjacent to the Trash Burn Pits
- At two locations downstream from the OB/OD areas.

The sample collection locations will be determined by the field personnel. Procedures for sample collection are described in Sections 4.3.4. All six of these samples will be analyzed for explosives, metals, and anions.

4.2.3. Sandblast Areas (SWMU-4)

4.2.3.1. Data Requirements. As discussed in Section 2.0, there are three Sandblast Areas in the Maintenance Area of N TEAD. Other than the analysis of used sandblast media as discussed in Section 2.0, there have been no previous environmental investigations of the sandblast areas. Because analysis of spent sandblast media suggests this material may be a hazardous waste, samples will be collected to determine if there has been a release of contaminants to nearby surface soils and surface water runoff areas.

4.2.3.2. Technical Approach. Up to six soil samples (total) will be collected from nearby surface soils and surface water runoff pathways. Sample locations will be determined judgmentally by the field sampling team. Two surface soil samples are designated for each of the three spent sandblast media collection points. The locations of the media collection points are shown in Figure 2-5. However, because the ground surface in the vicinity of the sample collection points is covered by concrete slabs and surrounding areas are paved (Figure 2-5), flexibility with regard to sample locations is necessary. Therefore, the actual number of samples and sample locations will be determined by the field sampling team. The sampling team will provide written rationale regarding the selection of sampling locations. Sample collection procedures are outlined in Sections 4.3.4. Samples collected from the Sandblast Areas will be analyzed for VOCs, SVOCs and metals.

4.2.4. Sewage Lagoons (SWMU-14)

4.2.4.1. Data Requirements. The sewage lagoons have been identified as a possible source of groundwater contamination by previous investigations. Although groundwater data is available in the vicinity of the sewage lagoons, the impact on groundwater quality from these lagoons is not understood. Data required to assess impacts of the sewage lagoons consist of:

- Characterizing the composition of contaminants present in the surface water and sediment in the sewage lagoons

- Characterizing the groundwater quality upgradient, cross gradient, and downgradient of the sewage lagoons

4.2.4.2. Technical Approach. Two samples of both surface water and sediment from the active sewage lagoon (Sewage Lagoon 1) will be collected to assess whether the sewage lagoon is a groundwater contamination source. Approximate surface water sample locations as shown on Figure 2-6, are located near the central portions of the active sewage lagoon to provide an indication of the general conditions present in the lagoon. The sediment sample will be collected near the inflow where sediments are likely to accumulate. The surface sediment sampling procedures are outlined in Section 4.3.5. All surface water and sediment samples will be analyzed for VOCs, SVOCs, metals, and anions. In addition, the two sediment samples will be analyzed for TCLP, VOCs, SVOCs, metals, and anions.

4.2.4.3. To confirm the presence or absence of contaminants downgradient of the sewage lagoon and to determine if the contaminants originate from the sewage lagoon or from other upgradient sources (e.g., the sanitary landfill), two rounds of groundwater samples will be collected from existing wells: N-134-90, B-1, N-135-90, N-117-88, and A-2 (Figure 2-6). Groundwater sampling procedures are discussed in Section 4.3.6. The groundwater quality in these wells will be compared with the sewage lagoon sediment and surface water samples to assess contaminant contributions from the lagoon. Groundwater samples will be analyzed for VOCs, SVOCs, metals, anions, and TRPH.

4.2.5. AED Demilitarization Test Facility (SWMU-19)

4.2.5.1. Data Requirements. No previous environmental investigations have been conducted at the AED Demilitarization Test Facility. Therefore, to meet the objectives of the Phase I RFI, the field investigations will be used to determine if there has been a release of contaminants to surface soils at the site. Contaminant releases could have occurred at several locations where demilitarization test activities were conducted and from Building 1376 where wash water or another spilled liquid is shown in historical aerial photographs.

4.2.5.2. Technical Approach. Twelve surface soil samples located judgmentally will be collected from the AED Demilitarization Test Facility. The general proposed locations, which are shown in Figure 2-7, are sited to provide general coverage of the facility. Specifically, four surface soil samples will be collected from the southeast end of building 1376 where historical aerial photographs show a liquid is present. One of these samples will be collected immediately down-hill from the concrete slab at each of the two doors (one per door). Two surface soil samples will be collected from a depression at the toe of a revetment south of the southeast end of Building 1376 where surface water may tend to pond. The remaining eight surface soil samples will be taken from test areas within the revetments at this facility and from an open area south of the facility where blast propagation testing has been conducted. A minimum of one sample will be collected from each of the test areas. The actual surface soil sample locations within these test areas will be determined by the field personnel based on observations made at the time of sampling. Samples may come from AED test areas, from stained or disturbed soils outside of buildings, or from other areas where indications of possible surface soil contamination are present. All soil samples will be analyzed for explosives, SVOCs, metals, and anions, and two of the samples will be selected for explosive reactivity testing based on field observations.

4.2.6. AED Deactivation Furnace Site (SWMU-20)

4.2.6.1. Data Requirements. With the exception of the analysis of baghouse dust, no previous investigations have been conducted at the AED Deactivation Furnace Site. Because metals were found in the baghouse dust and a release occurred at a facility with operations similar to SWMU-20 (the Deactivation Furnace Building (SWMU-21); see Section 2.2.5.), a contaminant release may have occurred at this facility. To determine if there has been a release, surface soil samples will be collected from around the perimeter of the AED Deactivation Furnace Site and potential wash water runoff areas.

4.2.6.2. Technical Approach. A total of 20 surface soil samples will be collected from the perimeter of the AED Deactivation Furnace Site. The proposed sample locations are shown in Figure 2-8. The actual sample locations will be determined judgmentally in the field by the sampling personnel. Surface soil sample collection procedures are discussed in Section 4.3.4. All soil samples will be analyzed for total metals, and two samples will be selected for TCLP metals analysis. Samples for TCLP metals will be selected based on the results of total metals analysis. The samples with the highest concentrations of total metals will be selected for TCLP analysis. For the other analyses, those samples which the field personnel judge, based on visual observations and flame ionization detector/ photoionization detector (FID/PID) readings to have the greatest probability of having hazardous waste characteristics will be submitted for analysis. In the absence of obvious contamination, samples for TCLP analysis will be selected from areas with the heaviest site usage (i.e., most active sites).

4.2.7. Deactivation Furnace Building (SWMU-21)

4.2.7.1. Data Requirements. The only previous investigations that have been conducted at the Deactivation Furnace Building have been limited to the analysis of dust collected from the floor under a conveyor and the analysis of baghouse dust. Metals and cresols were detected in the baghouse and floor dust. Because several compounds were detected in the dust and no environmental information is available for this site a surface soil investigation will be conducted to determine if there has been a release from this facility.

4.2.7.2. Technical Approach. A total of 16 surface soil samples will be collected from around the perimeter of paved areas at this SWMU. Although sample locations are shown in Figure 2-9, the field sampling team will have flexibility in selecting the actual sample locations based on judgment and observations at the time of sampling. Samples will be analyzed for SVOCs, metals, PCDDs, and PCDFs. Two samples will be selected for hazardous waste characterization according to TCLP analyses. Criteria for TCLP sample selection is available in Section 4.2.6.2. Surface soil sample collection procedures are discussed in Section 4.3.4.

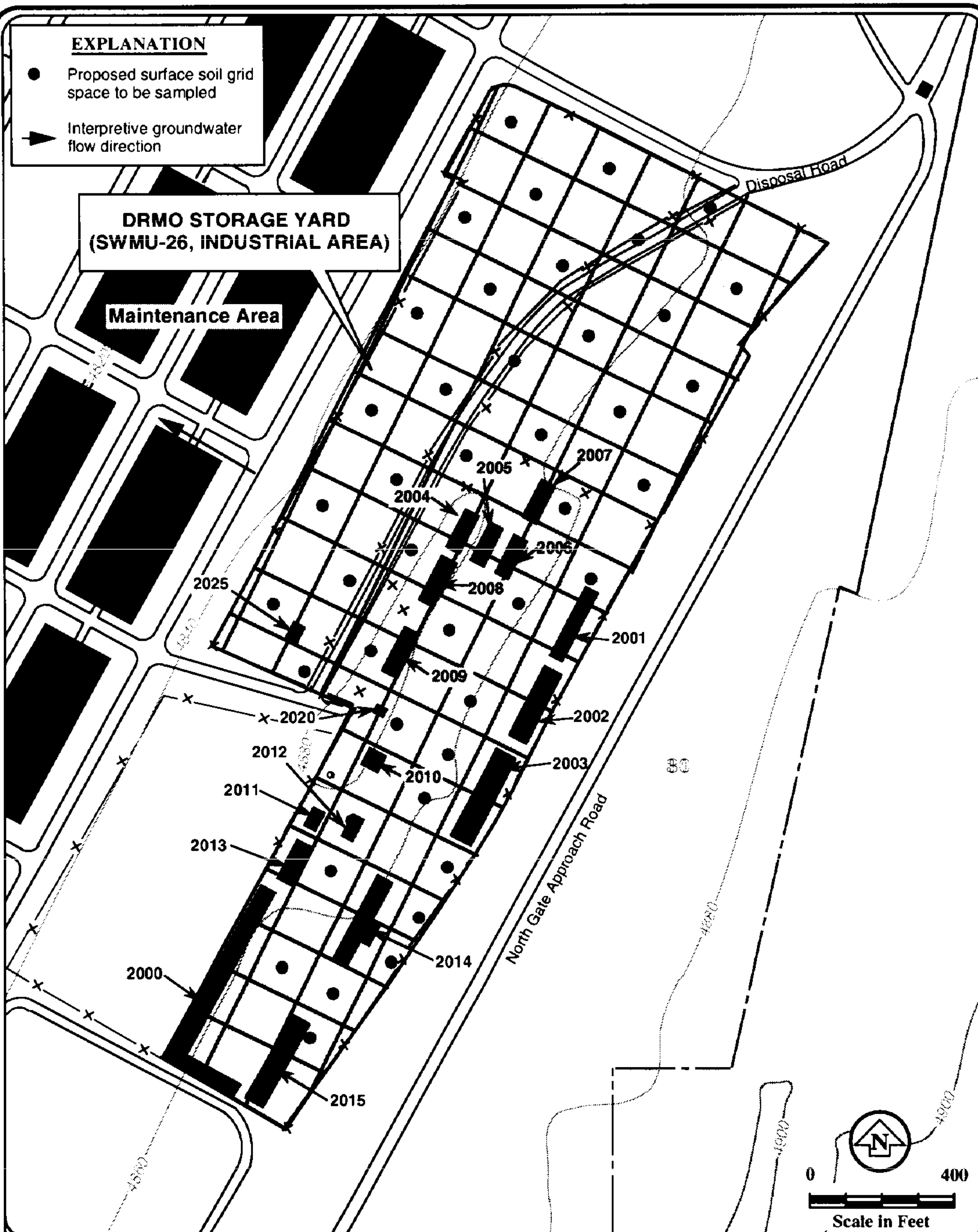
4.2.8. DRMO Storage Yard (SWMU-26)

4.2.8.1. Data Requirements. Although no previous sampling has been conducted in the DRMO Storage Yard, analyses of historical aerial photographs and past waste management handling practices indicate that a site investigation is required to meet the objectives of the Phase I RFI. An extensive soil sampling program has been developed to determine whether past waste handling practices have released contaminants to the surface and near-surface soils.

4.2.8.2. Technical Approach. The sampling program at this SWMU will provide general areal coverage of the entire DRMO Storage Yard while allowing flexibility in selecting actual sample locations. This approach consists of a combination of random and judgmental sample selection criteria. The sampling process consists of the following elements:

- Establishing a sampling grid that covers the entire DRMO Storage Yard as indicated in Figure 4-6
- Collecting 45 surface soil samples from stained areas or randomly picked locations in the sampling grid spaces
- Drilling a soil boring to approximately three feet bgs at each sample location
- Collecting a total of 15 shallow subsurface soil samples (approximately three feet bgs) from borings where there is evidence (i.e., discoloration, FID/PID readings above background) of subsurface contamination.
- Analyze all soil samples for VOCs, SVOCs, pesticides/PCBs, and metals.

4.2.8.3. The sampling grid, as shown in Figure 4-6, will be constructed using 150-foot spacing between grid lines. Sample locations within the grid spaces selected for sampling will be determined by two different methods. In those grid spaces where ground staining is observed, soil samples will be collected from the stained areas. If there are no obvious signs of contamination, the sampling location will be determined with a random number. A random number between 0 and 1 will be produced by a random number generator. The



Source: Modified from USGS Tooele 7.5 minute quadrangle.

JMM

SWMU-26
DRMO STORAGE YARD
GRID SAMPLE SPACES
FIGURE 4-6

PROJECT NO. 2942.0120

maximum north and east cell dimension (150 feet) will be multiplied by the random number. The resulting products will represent distances which will be measured from the southwest corner of each cell to define the sample location.

4.2.8.4. Each surface soil sample location (45 total) will be flagged in the field at the time of collection. These flags will be used to locate the subsequent soil boring that will be drilled to approximately three feet below the ground surface. Soil samples (15 total) will be selected from those borings that encounter evidence of subsurface contamination. All soil samples will be analyzed for VOCs, SVOCs, and metals. The surface and shallow subsurface soil sampling procedures are presented in Section 4.3.4.

4.2.9. Drum Storage Areas (SWMU-29)

4.2.9.1. Data Requirements. As indicated in Section 2.2.10 of this document, a review of the remedial investigation data from the drum storage areas indicates that a limited number of surface soil samples were analyzed. Analyses of aerial photographs reveal that the soils in several areas where drums were staged have not been sampled. To meet the objectives of the Phase I RFI, additional surface and subsurface soil data are needed to better quantify potential contamination source areas at this SWMU.

4.2.9.2. Technical Approach. The sampling program developed for this SWMU will provide general coverage of the areas where drums were known to have been stored while allowing flexibility in selecting actual sample locations. The approach consists of a combination of random and judgmental sampling according to the following program:

- Establishing a sampling grid in areas where historical aerial photographs and observations by persons knowledgeable with the site indicate drums were stored

- Randomly selecting 27 shallow boring locations in the sampling grid spaces. Drilling and collecting a surface (0 to 1 ft bgs) and a shallow subsurface soil sample (3 to 5 ft bgs) in each borehole

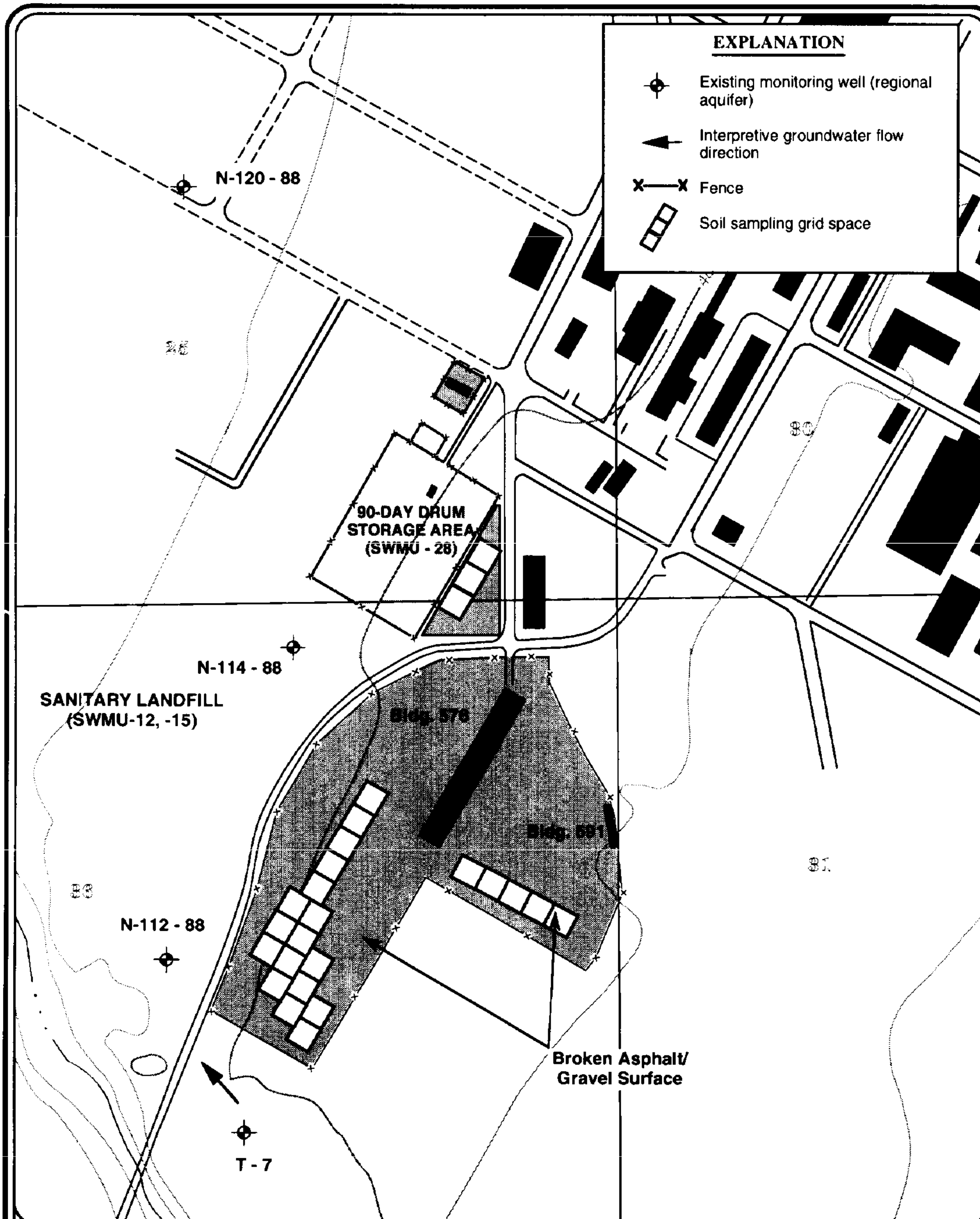
- Drill 10 five-foot deep soil borings in lowlying areas where precipitation runoff would tend to accumulate or flow, and collect a surface (0 to 1 ft bgs) and a shallow subsurface (3 to 5 ft bgs) soil sample per borehole.

4.2.9.3. A grid with 100-foot spacing covering the area where drums were stored, as shown in Figure 4-7, will be used to determine the 27 shallow soil boring locations. If any obvious signs of soil contamination are indicated within each grid space, these soils will be sampled. If no signs of contamination are present, the sample locations within each grid space will be picked randomly by multiplying the maximum grid dimensions (100 feet) by a random number between 0 and 1. The resulting products will be used to measure distances north and east of the southwest corner of each sampling grid space to define the sampling location. At each location, a five-foot deep soil boring will be drilled and sampled. A soil sample will be collected from 0 to 1 foot bgs from each borehole (27 total) for analysis of less mobile chemicals (i.e., metals and pesticides). In addition, one soil sample from each soil boring will be collected at depths of three to five feet bgs for metals, pesticides, VOCs, SVOCs, and TRPH analysis. These samples will be used to evaluate contaminant migration or evaluate whether surface soil has been buried during grading activities. Surface and shallow subsurface soil sampling procedures are described in Section 4.3.4.

4.2.9.4. Ten shallow soil borings will be drilled in areas that may be contaminated by surface water runoff from the Drum Storage Areas. The borehole locations will be positioned at topographic low areas, in drainage ditches, and in areas where spills onto the asphalt surface of the Drum Storage Area may have collected or run off. The exact locations of these shallow soil borings and samples will be determined judgmentally in the field by the field sampling team based on on-site observations. A shallow and a deep soil sample will be collected from each borehole. All 20 samples will be analyzed for metals and pesticides, and the 10 deep samples will be analyzed for VOCs, SVOCs and TRPHs.

4.2.10. Pesticide Handling and Storage Area (SWMU-34)

4.2.10.1. Data Requirements. Available information indicates that this SWMU has operated as a pesticide/herbicide handling and storage facility since the 1940s. Although present waste management practices conform to recommended guidelines, it is possible that in the past, contaminants were released to the surface soils in the vicinity of this facility. To meet the objectives of the Phase I RFI, surface soil samples will be collected from around SWMU-34 to determine if a release of contaminants has occurred.



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

0 400 800
Scale in Feet

SWMU-29
DRUM STORAGE AREAS
SAMPLING GRID SPACES
FIGURE 4-7

PROJECT NO. 2942.0120

4.2.10.2. Technical Approach. A total of five surface soil samples will be collected from the Pesticide Handling and Storage Area. As shown in Figure 2-15, four of the samples will be located around a concrete slab on the south side of the building where pesticides and herbicides are handled and the fifth surface soil sample will be collected from beneath a small outfall pipe that drains surface water from the pad. Actual sample locations will be determined in the field by the field sampling team based on observations at the time of sampling. All samples will be analyzed for pesticides, herbicides, and metals. Surface soil collection procedures are outlined in Section 4.3.4.

4.2.11. Contaminated Waste Processor (SWMU-37)

4.2.11.1. Data Requirements. Waste management practices at the Contaminated Waste Processor (CWP) indicate the potential for a release of metals, SVOCs, PCDDs and PCDFs to the surrounding surface soils. To satisfy the objectives of the Phase I RFI, surface soil samples will be collected from around the CWP.

4.2.11.2. Technical Approach. Twenty surface soil samples will be collected from areas around the CWP. Preliminary sample locations are shown in Figure 2-16. Actual sample locations will be determined judgmentally by the field sampling team. However, in the absence of visible contamination, four of the surface soil samples will be collected along the outside perimeter on each side of the facility. In addition, four surface soil samples will be collected around the staging area. All samples will be analyzed for metals, SVOCs, PCDDs and PCDFs.

4.2.12. Industrial Waste Treatment Plan (SWMU-38)

4.2.12.1. Data Requirements. According to available information, it is suspected that windborn granular activated carbon originating from open shipping containers stored at the IWTP may have contaminated the surface soil along the west side of this facility. To meet the Phase I RFI objectives, these surface soils will be sampled to determine if contamination is present.

4.2.12.2. Technical Approach. A total of five samples will be collected from the Industrial Waste Treatment Plant. The proposed sample locations are shown in Figure 2-17. Four samples will be collected from surface soils along the west side of the plant where the activated carbon was released. Actual sample locations from this area will be determined judgmentally by the field sampling team. Soil samples will be analyzed for VOCs, SVOCs, and metals. One sample of spent granular activated carbon will also be collected. The sample will be collected directly from the shipping container where the spent carbon is stored. The sample of spent carbon will be analyzed for VOCs, SVOCs, metals, and TCLP characteristics (VOCs, SVOCs, and metals). The surface soil and spent carbon sampling procedures are outlined in Section 4.3.4.

4.2.13. Bomb Wash Out Building (SWMU-42)

4.2.13.1. Data Requirements. Data generated from investigations conducted by the N TEAD EMO indicate that a release of contaminants to surface soils which received wash water from the facility may have occurred. To confirm that a release has occurred and to characterize the lateral distribution of contaminants that were released, an extensive field investigation of surface and shallow subsurface soils will be conducted. The specific data requirements are:

- Further delineate the distribution of contaminants in the surface and subsurface soils beneath the ditch and former holding pond area adjacent to the concrete flume

- Characterize surface and subsurface soil quality in the immediate vicinity of a second retort furnace

- Characterize surface soil quality within a 300-foot radius of the building to determine whether airborne emissions impacted the surrounding surface soils.

4.2.13.2. Technical Approach. An extensive surface and shallow soil sampling program will be conducted in the vicinity of the Bomb Wash Out Building. Preliminary soil boring and surface soil sampling locations are shown in Figure 2-19. Specific elements of the field sampling program include:

- Drilling seven soil borings to approximately five feet bgs along the wash water discharge flume, wastewater ditch, and holding pond and, selecting two samples per borehole (14 total) for metals and explosives analysis

- Drilling four shallow soil borings to approximately five feet bgs at locations on either side of the discharge ditch and holding pond, and selecting two samples per borehole (8 total) for metals and explosives analysis

- Drilling four soil borings to approximately five feet bgs around the former location of the second furnace, and selecting two samples per borehole (8 total) for metals and explosives analysis

- Selecting three samples for TCLP, explosives, and metals analysis

- Collecting four surface soil samples from locations within a 300-foot radius of the Bomb Wash Out Building for explosives and metals analysis. Select one sample for TCLP metals and explosives analysis to evaluate hazardous characteristics.

The soil boring drilling procedures and the surface and shallow subsurface soil sampling procedures are outlined in Section 4.3.4.

4.2.14. Stormwater Discharge Area (SWMU-45)

4.2.14.1. Sampling Requirements. Some preliminary samples taken from the Stormwater Discharge Area revealed the presence of VOCs in surface water and sediments. To satisfy the objectives of the Phase I RFI, additional samples of surface water and sediment will be taken to confirm the presence of VOC and other types of contaminants at this SWMU.

4.2.14.2. Technical Approach. A total of five surface water and five sediment samples will be collected from the area where ponded water occurs from stormwater discharges. Actual sample locations will be determined judgmentally by the field sampling team based on observations made at the site. The samples will be analyzed for VOCs, SVOCs, metals, explosives, and pesticides. A 25-foot deep soil boring will be drilled and sampled at a location as close to the ponded water as possible. Seven samples from the boring will be selected for analysis of VOCs, SVOCs, metals, and explosives. Soil boring procedures and the surface and shallow subsurface soil sampling procedures are outlined in Section 4.3.4.

4.2.15. Used Oil Dumpsters (SWMU-46)

4.2.15.1. Sampling Requirements. As described in Section 2.0 and shown in Figure 2-23, this SWMU has many separate locations around the Administration and Maintenance areas of N TEAD. Samples of surface soils and shallow subsurface soils will be collected to determine if these used oil dumpsters are sources of contamination.

4.2.15.2. Technical Approach. Up to 56 soil samples will be collected from surface and shallow soils in the vicinity of the used oil dumpsters (Figure 2-23). Because many of the used oil dumpsters rest on concrete or asphalt slabs and roadways, the exact number of samples that will be collected is unknown. Where possible, two samples of surface soils and two samples of subsurface soils (approximately 1 ft bgs) will be collected at each dumpster. In addition, surface soils and shallow subsurface soils in surface water runoff pathways will be sampled. Actual sample locations will be determined judgmentally in the field by the field sampling team. All soil samples from this SWMU will be analyzed for total petroleum hydrocarbons. Refer to Section 4.3.4. for sampling procedures.

4.2.16. Boiler Blowdown Water (SWMU-47)

4.2.16.1. Sampling Requirements. As indicated in Section 2.0 and depicted in Figure 2-24, this SWMU has three locations: Building 606, 610, and 637. Boiler blowdown water discharged at each of these locations is suspected of containing contaminants that may be released to nearby soils and surface water. To meet the objectives of the Phase I RFI and to determine if the boiler blowdown water is releasing contaminants to the environment, samples of surface water and sediment will be collected from each boiler blowdown water location.

4.2.16.2. Technical Requirements. At each of the three boiler blowdown water locations, up to two surface water and two sediment samples will be collected from areas where the boiler blowdown water is discharged. The surface water and sediment samples will be analyzed for VOCs, SVOCs, metals, and TRPH. The surface water and sediment sampling procedures are outline in Section 4.3.5.

4.3 FIELD SAMPLING PROCEDURES

4.3.0.1. This subsection contains the procedures that will be used for the Phase I RFI field investigation programs.

4.3.1. Unexploded Ordnance Support

4.3.1.1. UXB International, Inc (UXB) will assist JMM and its subcontractors while conducting Phase I RFI investigations in the Open Burning/Open Detonation Areas (SWMUs-1, -1a, -1b, -1c, and -1d) by providing a safe working environment in areas where the potential of encountering unexploded ordnance (UXO) exists. The scope of UXB's activities includes:

- Site inspections to determine whether explosively reactive material is present at each of the five OB/OD subareas
- Excavation of 139 five-foot deep test pits and 16 eight-foot deep test pits
- UXO clearance for eight 100-foot deep soil borings
- UXO safety escort for geophysical surveys
- UXO safety escort for field topographic surveys.

A complete description of the work plan for UXO surveys and excavations is included in Appendix F of the HASP.

4.3.2. Geophysical Investigation

4.3.2.1. Introduction. Two geophysical survey methods will be used in the Propellant Burn Pad and Trash Burn Pits subareas of the OB/OD area. The purpose of the surveys is to confirm locations of the burial trenches and disposal pits and to identify other potential sources of environmental contamination that may be present. The geophysical surveys will be conducted by Practical Geophysics.

4.3.2.2. Method Summary. A series of steps will be conducted during the geophysical survey. The steps are outlined below:

1. Roadway intersections common to all historical aerial photographs (1952, 1959, 1966, and 1981) will be identified as points of reference on each aerial photograph.

2. A preliminary field survey of distances and horizontal angles between these roadway intersections will be conducted in the field.

3. Using the known distances and horizontal angles, each historical aerial photograph will be digitally rectified and reproduced at a common scale (1:1200).

4. Using the digitally rectified aerial photographs, all distances and bearings to images of pits and trenches will be determined.

5. The distances and bearings will be used to identify the old pits and trenches in the field using topographic survey techniques.

6. Geophysical survey methods will be used to verify the locations of pits and trenches and to determine the areal extent of disturbed soil and/or buried material.

7. Once located by direct survey methods and confirmed and outlined by indirect geophysical methods, a given site will be staked and numbered for subsequent test pit excavations.

4.3.2.3. Terrain conductivity and geomagnetics survey methods that will be used to confirm burial pit and trenches locations . Descriptions of the survey methods, equipment, and calibration techniques are presented below.

4.3.2.4. Terrain Conductivity Survey. Terrain conductivity measurements will be made using a Geonics Limited EM-31 soil conductivity system. This instrument, designed to be carried by one person, measures the conductivity of subsurface soil with transmitting and receiving coils mounted in a horizontal coplanar configuration in a 12-foot boom. The instrument outputs a continuous signal until a material with a different conductivity is encountered, such as buried wastes or changes in subsurface lithology. The instrument is designed to measure variations caused by conductivity changes. Signal variations (anomalies) are a result of the average variation in soil conductivity between the transmitting and receiving coils to a depth of approximately six feet. Signal strength is factory calibrated and read directly in millimhos per meter (mmhos/m). The soil conductivity meter has full scale sensitivities of 3, 10, 30, 100, 300, and 1,000 mmhos/m. These variable ranges make it possible to accommodate a wide range of conductivity variances.

4.3.2.5. The instrument can be operated in a reconnaissance mode by monitoring its continuous output until an anomalous zone is detected along a traverse. Once detected, this zone can be surveyed on a point by point basis to fully delineate the extent of the anomaly.

4.3.2.6. The EM-31 terrain conductivity survey system will be self-tested to insure that it is functioning properly prior to use in the field. A field calibration profile site will be selected that has obvious soil conductivity variations (e.g., native soil against a road base) to establish a basis for checking the repeatability of measurements displayed by the instrument. The instrument will be calibrated twice daily.

4.3.2.7. Geomagnetic Survey. Ferromagnetic material that may be buried in the burial pits and trenches will be searched for using a proton procession magnetometer, GEM Systems Model GSM-8 with a one-gamma (one nanotesla) sensitivity. This instrument will be used to measure the Earth's background magnetic field strength (total), which is approximately 54,200 gammas in the vicinity of the southwestern portion of N TEAD.

Subsequent measurements taken in the burial pit and trench areas will be compared to the background measurements to determine whether ferromagnetic material is present.

4.3.2.8. Anomalous magnetic measurements over burial sites can be expected from both small ferromagnetic objectives or from one or more large (several pounds) ferromagnetic objects. Non-ferromagnetic metals such as copper, brass, aluminum, and stainless steel do not have detectable magnetic anomalies. For example, a one-pound mass of iron will add over 500 gammas (anomaly) to the measured total magnetic field strength when the magnetometer sensor is at a distance of one foot above the iron mass. As the distance between the sensor and one-pound mass of iron increases the amplitude of the anomaly decreases by a factor of distance cubed. If the distance between the one-pound mass and the sensor was increased to five, the anomaly amplitude would decrease by a factor of 125.

4.3.2.9. Given the lateral extents and thick sequence of unconsolidated nonmagnetic soil in the vicinity of the southwest corner of N TEAD, total magnetic field measurements are expected to be nearly constant across the area. If ferromagnetic objects are contained within a given disposal site, the total field measurements taken over these sites will exhibit anomalies. It cannot be assumed that all burial pits and trenches will contain magnetic material, but those that do will display a magnetic signature to help identify their locations.

4.3.2.10. To ensure that the magnetometer is functioning properly, the magnetic sensor will be placed on the ground and a measurement will be made of local ambient field strength. Without moving the sensor, a common ferromagnetic object (e.g., wrench or screwdriver) will be placed a fixed distance from the sensor and a second measurement will be taken. A change in the field strength will be noted if the instrument is working properly. This exercise can be duplicated at any time with essentially identical results, if the instrument remains in proper working condition.

4.3.2.11. If it is suspected the Earth's magnetic field is being affected by a magnetic storm related to sunspot activity additional background tests will be taken. Magnetic storms can cause changes of 10 to 100 gammas in the observed field strength in short periods of time (a few seconds). To determine if the ambient field is stable, a series of magnetic measurements as described above will be taken during a period of several minutes.

4.3.2.12. All measurements and equipment checks will be performed by the subcontractor, Practical Geophysics. Instrument performance will be evaluated at the beginning and end of each day, and at any time the subcontractor feels it is necessary.

4.3.3. Test Pit Excavation and Soil Sampling

4.3.3.1. Introduction. Test pits will be used to explore the shallow subsurface conditions in the OB/OD areas. All test pits will be excavated by the UXO subcontractor using a rubber-tired backhoe. Test pits were selected in favor of soil borings at this SWMU for the following reasons:

- Less personnel in the work zones (i.e., no drilling subcontractor)
- There is more distance between the equipment operator and the excavation location using a backhoe compare to a drilling rig
- Visual observations of the subsurface conditions and buried debris are much more detailed than visual observations from soil borings
- Because the soils beneath much of the OB/OD areas are gravelly and unconsolidated, soil sample recovery from the backhoe bucket will be better than recovery from drive-type or continuous core-type soil samplers.

4.3.3.2. Scope of Work. The scope of work for the test pit excavation program consists of the following:

- Excavating 155 test pits to depths of five to eight feet bgs in the vicinity of SWMUs-1, -1a, -1b, -1c, and -1d
- Geologically logging, sketching, and photographing each test pit excavation from the ground surface
- Collecting two soil samples that exhibit evidence of environmental contamination from each pit (310 total) for chemical analysis

- Conducting a colorimetric field test (Appendix D) for nitroaromatic compounds if the sample contains dark red staining, buff-colored crystals, or a nitroaromatic odor

- Monitoring air quality in the exclusion zone for VOCs using an FID or PID

- Decontaminating the excavating and sampling equipment, and storing the rinsate water in 55-gallon drums

- Identifying each test pit excavation in relation to the field survey.

4.3.3.3. Test Pit Excavation Procedures. The following procedures will be followed when conducting test pit excavations:

- The excavation area will be cleared of UXO by the UXB technician

- The outline of the test pit will be marked with wooden stakes by the UXB technician and JMM field personnel

- Site work zones, including an exclusion zone around the excavation, will be established as described in the HASP

- Subsurface soils will be excavated by the UXB technician until either buried materials are encountered or a desired sampling interval is reached. All excavated soil will be placed adjacent to the open trench and examined by the UXB technician to determine if UXO is present

- If buried materials are encountered, excavation will continue using hand tools to carefully remove soil around the buried items. If UXO or other hazardous items are encountered, the items will be removed and placed at a designated storage area for handling by the Tooele Explosives Ordnance Disposal (EOD) Unit

- If drums or other hazardous chemicals are encountered, the excavation will be halted until an assessment can be made regarding health and safety by the on-site safety officer. If organic vapors greater than five parts per million (ppm) above background are detected with the FID or PID or other indications of potential hazards are present, the excavation will be continued only after personal protective equipment upgrade as defined in the HASP is made

- After each test pit and excavated soil have been cleared of exposed UXO and metallic debris, the contents of the excavation (less any ordnance), will be placed back into the excavation using the front-end loader of the backhoe.

4.3.3.4. Soil Sampling Procedures. The presence of environmental contamination in the soils of the OB/OD areas will be determined by analyzing samples collected from the test pit excavations. In general, samples will be collected from soils exhibiting signs of contamination. Criteria to be used for collecting these samples are as follows:

- Soils exhibiting visual signs of contamination such as discoloration or the presence of foreign material

- Soil collected immediately beneath buried debris

- Soil containing a high percentage of organic matter or fine-grained particles (clay or silt) where contaminants may be concentrated through sorption

- Soil containing calcium carbonate where metals may be likely to accumulate

- Soil exhibiting signs of disturbance in the past.

4.3.3.5. As each sample is collected, its location within the pit will be measured from a reference stake located at the end of the pit. In general, all soil samples will be collected from the backhoe bucket. In the event that hand excavation becomes necessary, JMM personnel will designate locations for by UXB personnel to collect samples. Samples will be collected using a decontaminated stainless steel shovel.

4.3.3.6. Soil samples will be transferred from the backhoe bucket to analyte-specific sample containers using a decontaminated stainless steel hand trowel. Decontamination procedures are discussed Section 4.3.8., and sample containers and handling procedures are discussed in Sections 5.0 and 6.0 of this document, respectively. Test pit soil sample designations are described in Section 3.0 of the *Data Management Plan* (DMP).

4.3.4. Soil Sampling and Spent Carbon Sampling Procedures

4.3.4.1. Introduction. A variety of soil samples will be collected according to the SWMU-specific investigation techniques described in Section 4.2. In addition to the soil samples collected from test pits, three general types of soil samples will be collected during the field investigations: (1) surface soil samples, (2) shallow subsurface soil samples, and (3) deep soil samples. The following subsections describe the methods and equipment that will be used to collect each of these types of soil samples.

4.3.4.2. Surface Soil Sampling. Surface soil samples will be collected at all the SWMUs included in this field investigation program except the Sewage Lagoons, Stormwater Discharge Area, and Boiler Blowdown Water Areas. As discussed in Section 4.2, two procedures, judgmental and random, will be used to locate surface soil samples. In areas where obvious signs of contamination are observed and at background soil sample locations, judgmental sampling procedures will be used. Surface soil samples will be collected from a single location determined by the sampling personnel. The samples will be taken from the ground surface using a decontaminated stainless steel hand trowel or similar equipment and placed into a decontaminated stainless steel bowl for homogenization. After the soil is homogenized, the soil will be placed directly into the analyte-specific sample containers. This method will be followed for all samples except for those samples to be analyzed for VOCs. VOC samples will not be homogenized to avoid volatilizing contaminants. The VOC sample containers will be filled directly from the sampling trowel. All surface soil samples will be collected from the top two inches of soil. All samples will be handled as specified in Sections 5 and 6 of this document.

4.3.4.3. At random sampling locations or locations where there are no obvious signs of contamination, surface soil samples will be collected by compositing five aliquots taken from the upper two inches of surface soil. Aliquot sampling allows a larger area to be sampled and provides an average measure of soil conditions. At random sampling locations, the samples will be collected five feet in each direction from the randomly determined sample location. At non-random sample locations, the aliquots will be collected at five, one-foot intervals along a straight line traverse, parallel to any manmade features (i.e., concrete slabs or parking lots, stream channels, drainage ditches, etc.). Aliquots will be composited in a stainless steel bowl and homogenized prior to placement in the analyte-specific sample containers. Samples for VOC analysis will not be homogenized. VOC sample containers will be filled with equal portions of soil from each of the five aliquot locations. All soil samples will be handled as specified in Sections 5.0 and 6.0 of this document.

4.3.4.4. Shallow Subsurface Soil Sampling. At five of the SWMUs (the DRMO Storage Yard, the Drum Storage Areas, the Bomb Wash Out Building, the Stormwater Discharge Area, and the Used Oil Dumpsters), shallow subsurface soils will be sampled. At each of these locations, shallow boreholes will be drilled to the target sampling interval using either hollow-stem auger drilling techniques, a hand-auger, or a stainless steel shovel (e.g., at the Used Oil Dumpster locations).

4.3.4.5. Where hollow-stem auger drilling techniques are used work zones including an exclusion zone will be set up around the drilling rig. Drilling and sampling equipment will be decontaminated to the satisfaction of the rig geologist before drilling each borehole. Continuous core samples will be collected from the ground surface as the boreholes are advanced. Once the borehole reaches the predetermined target depth, the sampler will be retrieved and opened for visual inspection. Soil samples for chemical and geotechnical analysis will be selected from the continuous cores. Samples will be removed from the soil sampler using a decontaminated stainless steel trowel and placed directly into the analyte-specific sample containers. All samples will be handled as specified in Sections 5.0 and 6.0 of this document.

4.3.4.6. Soil cuttings generated during shallow subsurface soil sampling activities will be examined for obvious signs of contamination including discoloration, odor, and organic vapors. The soil cores will be scanned for VOCs using either an FID or PID. If no visible contamination or elevated readings are present, the auger cuttings will be returned to the shallow boreholes as backfill. If obvious signs of contamination and/or organic vapor readings above background are measured, the cuttings will be drummed and handled as described in Section 4.3.9. Decontamination procedures are described in Section 4.3.8.

4.3.4.7. Several one-foot deep soil samples are planned in the vicinity of the Used Oil Dumpsters (SWMU-45). These samples will be collected using a hand-operated stainless steel bucket auger or stainless steel shovel. After the desired sampling interval is reached, the soil sample containers will be filled directly from the bucket auger or shovel. Cuttings generated at hand-augered borings will be observed for obvious signs of contamination. In addition, the cuttings will be scanned for organic vapors using either an FID or PID. Cuttings that have no obvious signs of contamination will be replaced in the boreholes. Cuttings that contain visible contamination or produce organic vapors above background levels will be drummed for subsequent handling or disposal.

4.3.4.8. Deep Soil Sampling. Nine 100-foot deep soil borings will be drilled at various locations in the OB/OD areas. Because coarse gravels underlie much of N TEAD, a percussion-type dual walled reverse-circulation air rotary drilling rig will be used. Work zones will be set up around the drilling rig and all but the necessary personnel will be excluded from the area. Soil samples will be collected through the inside of the drill pipe using decontaminated split-spoon drive samplers. Each boring will be sampled on a five-foot interval, and seven samples from various depths will be selected for chemical analyses. Samples for chemical analysis will be selected by the sampling personnel using criteria listed in Section 4.3.3. However, if none of the sampling criteria are met samples will be selected from the 5, 10, 20, 35, 50, 75, and 100-foot depth intervals. To provide sufficient soil volume, samples will be removed from the retrieved split-spoon samplers and placed into a stainless steel bowl for compositing. After homogenization, the soil will be placed into analyte-specific sample containers with a decontaminated stainless steel trowel or similar equipment. All samples will be handled as outlined in Sections 5.0 and 6.0 of this document.

4.3.4.9. Because there is a potential for encountering UXO, downhole geophysical surveys will be conducted ahead of the drill pipe until a depth of 20 feet below the ground surface is reached. Since the drilling rig and drill pipe may interfere with the geophysical survey, a three to four-inch diameter PVC casing will be inserted inside the drill pipe, the drill pipe removed from the borehole, and the drill rig removed from the immediate vicinity. After the geophysical survey indicates that the interval below the bottom of the PVC is clear, the drill rig will reoccupy the site and overdrill around the PVC casing. Because the down-hole geophysical survey is limited to four feet, five iterations of subsurface surveying and drilling will be necessary to reach the 20-foot depth. If the geophysical survey indicates UXO may be present, another borehole location, offset approximately 10 feet, will be selected and the process started again.

4.3.4.10. Cuttings extracted from the deep soil borings will be handled in the same manner as those from the shallow soil borings. Drill cuttings and excess soil from the split-spoon samples will be inspected visually for evidence of contamination and screened for the presence of organic vapors using either an FID or PID. If visual evidence of contamination is observed and/or the PID or FID measurements are above background, the material will be considered contaminated and will be containerized in 55-gallon steel drums. If no signs of contamination are observed, drill cuttings will be spread out onto the ground surface in the vicinity of the borehole. Deep boreholes will be grouted back to the ground surface using a cement-bentonite grout prepared according to State of Utah regulations. The bentonite will be approved according to the guidelines outlined in the USATHAMA Geotechnical Requirements (Appendix A). A request for bentonite approval will be submitted to the USATHAMA Contracting Officer two weeks before field work begins. The request will be made in writing using the form shown in Figure 4-8.

4.3.4.12. Spent Carbon Sampling. One sample of spent granular activated carbon is scheduled to be collected at SWMU-38. This sample will be taken directly from the shipping container where the spent carbon is stored from approximately six inches below the surface of the carbon. A stainless steel trowel, hand bucket auger, or similar sampling tool will be used to sample the spent carbon. The spent carbon will not be homogenized and will be placed directly into the analyte-specific sample containers. Sampling personnel will follow the health and safety procedures as outlined in the HASP. All samples will be handled as specified in Sections 5.0 and 6.0 of this document.

4.3.5. Sediment and Surface Water Sampling Procedures

4.3.5.1. Introduction. Samples of surface water and sediment will be collected from the Sewage Lagoons (SWMU-14), the Stormwater Discharge Area (SWMU-45), and the Boiler Blowdown Water Areas (SWMU-47). All samples will be handled as specified in Sections 5.0 and 6.0 of this document. Specific discussions of the sampling equipment and procedures that will be used to sample each of these media are presented below.

4.3.5.2. Sediment Sampling. Sediment samples will be taken in conjunction with surface water samples to help define the partitioning of chemicals between the soil and water. Sediment samples will be collected from each of the three SWMUs listed above

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:
2. Bentonite Manufacturer:
3. Manufacturer's Address and Telephone Number:
4. Product description (from package label or attached brochure):
5. Intended Use:

SUBMITTED BY:

Company

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:

	(check one)	
Project Officer/Date:	A	D
Project Geologist/Date	A	D

PROJECT NO. 2942.0120

JMM

N TEAD
BENTONITE APPROVAL REQUEST FORM
FIGURE 4-8

using either a gravity corer or clamshell-type sampler or scoop constructed of inert materials (i.e., stainless steel or Teflon). The type of sampler which will be used to collect the samples will be determined by the field personnel. Prior to sample collection, the sediment sampling equipment that may contact sample material will be decontaminated according to the procedures outlined in Section 4.3.8. Sediment samples will be collected near the water discharge points at each SWMU. A minimum of 500 grams of sediment should be collected at each sampling location. Depending upon the thickness of the sludge and recovery efficiency of the sampler, the number of cores or clamshell buckets necessary to collect the required volume will vary and will be determined by the samplers at the time of sampling. Sediment for VOC analysis will not be homogenized and will be placed directly into the appropriate sample container using a stainless steel trowel or spoon. The sediment for all other analysis will be placed in a stainless steel bowl and homogenized before placement into the analyte-specific sample containers.

4.3.5.3. Surface Water. Surface water samples will be collected in the following manner:

- The field sampling team will document whether any light non-aqueous phase liquids (LNAPLs) are present on the surface water

- The field sampling team will determine the exact sampling location at the time the samples are collected. The sample will be taken where the surface water is well-mixed and representative of the overall water body. Sediment or soil from the bottom of the water body will not be introduced into the sample

- The following parameters will be measured prior to sample collection and recorded on the surface water sampling form:

  PID or FID reading over the surface water
  Water temperature
  Water pH
  Specific conductivity
  Visual appearance of the water

- The volume of acid or base (if necessary) required to meet the sample preservation requirements outlined in Table 5-4 will be determined

- Prior to sampling analyte-specific sample containers will be triple rinsed with the surface water to be sampled

- If LNAPLs are present, the sample containers will be filled by immersing each sample container so the LNAPLs are included in the sample

- If LNAPLs are not observed each sample container will be filled immediately by immersing it below the surface of the water to avoid floating debris

- Samples for metals analysis will be filtered after collection using a peristaltic pump equipped with Teflon tubing and an in-line, disposable, 0.45 micron disposable filter

- If required, the appropriate predetermined volume of preservative will be added to the sample (see Table 5-4). The pH of the sample will be checked using a pH test strip. Air bubbles will be removed from VOC containers before capping

- All samples will be handled as outlined in Sections 5 and 6 of this document.

4.3.5.4. The sampling personnel collecting surface water samples from the Stormwater Discharge Area and the Boiler Blowdown Water Areas will be able to stand or kneel on the ground surface adjacent to the surface water for sample collection. A small boat will be used to collect the surface water and sediment samples from the sewage lagoon. Sampling personnel will collect the surface water from the central portion of the sewage lagoon where representative surface water conditions exist.

4.3.6. Groundwater Sampling

4.3.6.1. Two rounds of groundwater samples will be collected from five wells in the vicinity of the Sewage Lagoons (SWMU-14). Except for the wells which have dedicated bailers, groundwater sampling equipment will be decontaminated prior to use and after use in accordance with the procedures outlined in Section 4.3.8. Sampling equipment calibration will follow the recommended procedures in Section 6.7 of this document. All information will be recorded directly onto the groundwater sampling forms presented in

Section 4.1. All samples will be handled as specified in Sections 5.0 and 6.0 of this document. In general, sampling will proceed from the least contaminated to most contaminated wells as can best be determined from existing data. The following paragraphs describe groundwater sampling techniques in terms of pre-purging activities, purging activities, and sample collection.

4.3.6.2. Pre-purging Activities. Prior to sample collection five casing volumes of groundwater will be purged from the well to ensure groundwater samples are representative of the aquifer. The following activities will be performed to prepare for monitor well purging:

- The monitoring well will be checked for proper identification and any signs of tampering

- After unlocking the well and removing any well caps, measure and record the ambient and well-head for organic vapor using either an FID or PID. If the ambient air quality at breathing level reaches 5 ppm above background, the sampler will utilize the appropriate safety equipment as described in the HASP

- Using the electronic water level meter, measure the static water level and total well depth from the top of the well casing, and record the information on the groundwater sampling form. After removing the measuring equipment, rinse it with water from the approved source, and then rinse it with distilled water. All rinsate will be collected in 55-gallon drums for disposal at the IWTP.

- Calculate the volume of water to be purged from the monitoring well using the annular and borehole volumes as follows:

Casing Volume:
$$V_c = \pi r_1^2 h_1 \qquad (4\text{-}1)$$

where:
V_c = Casing Volume (ft^3)
r_1 = inside radius of monitoring well casing (ft)
h_1 = height of water column (i.e., bottom depth - depth of static water) (ft)

Annular Volume: $$Va = (\pi r_2^2 - \pi r_1^2)\, h_2 \qquad \text{4-2}$$

where:

V_a = annular volume (ft^3)

r_2 = estimated radius of borehole (ft)

r_1 = outside radius of well casing (ft)

h_2 = total vertical saturated thickness of sandpack (ft)

Total Purge Volume: $$V_t = X\,(V_c + V_a n) \qquad \text{4-3}$$

where:

V_t = Total Purge Volume (ft^3)

V_c = Volume of water in well casing (ft^3)

V_a = Volume of water in well annulus (ft^3)

n = Estimated porosity of sandpack = 0.30

X = No. of purge volumes to be removed prior to sampling = 5 (USATHAMA, 1987b)

To convert to gallons:

$$V_t\,(\text{gal}) = \left(V_t(\text{ft}^3)\right)\left(\frac{7.48\ \text{gal}}{\text{ft}^3}\right) \qquad \text{4-4}$$

4.3.6.3. Purging Activities. The following activities will be conducted during well purging:

- A decontaminated stainless steel submersible pump with Teflon fittings will be used to purge each well. The pump will be placed just below the top of water column (the pump intake should not be lowered below the top of the well screen). All materials used to suspend the pump will consist of inert material (i.e., nylon or Teflon).

- Measure pH, specific conductance, and temperature once for every casing volume and record the measurements on the Groundwater Sample-Field Data Form

- Purging is considered complete when five well volumes, as calculated in Item 4-4 above, have been removed from the well

- Collect all purge and excess sample water in 55-gallon drums or other containers for subsequent disposal at the IWTP.

4.3.6.4. Sample Collection. After well purging is completed and the pump has been removed, the following procedures will be used to collect groundwater samples:

- All groundwater samples will be collected using a decontaminated or dedicated Teflon or stainless steel bailer. A new nylon or polypropylene rope will be used at each sampling location to lower the bailer to the middle of the screened interval.

- Retrieve the full bailer. Do not allow the rope to contact the ground.

- Determine the volume of each preservative (as necessary) that will be required to meet the method specifications shown in Section 5.0.

- Fill the analyte-specific sample containers as discussed in Section 5.0 of this DCQAP. All sample vials or bottles will be triple-rinsed with sample water prior to collection, except for VOC samples. Samples will be poured directly from the bailer into the appropriate rinsed containers. VOC sample containers will be filled with as little agitation as possible.

- Filter samples for metals analysis using a peristaltic pump equipped with Teflon tubing and an in-line, disposable, 0.45 micron filter.

- Add the predetermined volume of preservative to the appropriate samples. Check pH using a pH test strip.

- Record sampling data on the Groundwater Sample-Field Data Record.

- Remove the bailer from the well. If the bailer is dedicated, reattach the bailer to the well cap. Decontaminate non-dedicated bailers by steam-cleaning with water from the approved source.

- Secure the well cap and lock.

4.3.7. Geotechnical Testing

4.3.7.1. Introduction. Approximately 12 percent (96) of the soil samples collected during the Phase I RFI at N TEAD will be submitted for geotechnical analyses. Geotechnical analytical results will be used as a basis to confirm on-site lithologic descriptions of test pits and soil borings. All geotechnical analyses will be conducted according to the appropriate American Society for Testing and Measures (ASTM) methods. Geotechnical analyses scheduled for this program include particle size determination using sieve and Atterberg limit analysis (ASTM D422-90 and ASTM 4318-84) and a determination of specific gravity (ASTM 854-90).

4.3.7.2. Soil samples selected for geotechnical analysis will be determined in the field using the following criteria:

- At least one representative sample of each soil horizon sampled at each SWMU

- At least one representative soil sample of each horizon encountered at the background soil sampling locations

- Representative samples of each major soil unit encountered in the 100-foot deep soil borings in the OB/OD areas

- Approximately one pint of soil will be collected for geotechnical analysis. The sample will be double-bagged in Ziploc® freezer-type bags to maintain the in-situ moisture content. Samples will be analyzed by Dames & Moore, Inc. at their geotechnical laboratory in Salt Lake City.

4.3.8. Decontamination Procedures

4.3.8.1. To prevent cross contamination and to protect the field sampling personnel, downhole drilling equipment, sampling equipment, and backhoe buckets will be decontaminated before use and at the completion of each soil boring test pit or sampling episode. Decontamination will consist of steam-cleaning at a decontamination pad constructed specifically for this purpose. Description of the decontamination pad construction is included in Section 4.1.

4.3.8.2. All drilling equipment will be steam cleaned prior to arrival at N TEAD. In addition, the equipment will be steam cleaned on site using water from the approved water source. Paint applied by the equipment manufacturer will not be removed from the drilling equipment. Miscellaneous tools and sampling equipment used for multiple sample collection will also be steam cleaned between samples using water from the approved water source.

4.3.8.3. Drill Rig, Backhoe, and Other Tools. It is anticipated that the drill rigs and backhoe may become contaminated during exploration activities. If muddy conditions exist or it is suspected that these pieces of equipment have become contaminated for any reason, they will be cleaned using a combination of high-pressure water and steam at the decontamination pad. No solvents or surfactants will be used. Loose materials will be removed by brush. Persons conducting steam cleaning activities at the decontamination pad will be required to wear Level D personal protective equipment plus splash protection.

4.3.8.4. In addition to the decontamination pad, a temporary decontamination station may be used to clean soil augers, soil samplers, bailers, and other small tools and equipment. This temporary decontamination station would likely consist of a portable steam cleaner and a galvanized steel water tank in which equipment will be placed for steam cleaning. Rinsate which would accumulate in the bottom of the tank, would be pumped from the tank to 55-gallon drums or other suitable containers for subsequent treatment and disposal at the Industrial Waste Treatment Plant. To save time, a temporary decontamination station could be established as needed at each of the SWMUs.

4.3.8.5. Purge and Peristaltic Pumps. The pumps used to purge the wells and filter water samples will be decontaminated by steam cleaning as described in the preceding paragraphs, and by pumping three pump volumes (sum of pump volume and discharge tubing volume) of distilled water through the systems. All rinsate will be collected for disposal at the IWTP. The Teflon tubing in the peristaltic pump will be decontaminated by purging one quart of distilled water through the tubing. Tubing will be replaced any time degradation is observed by field personnel.

4.3.9. Investigation-Derived Waste Handling

4.3.9.1. Because of the extensive nature of the field sampling program, significant quantities of investigation-derived wastes (IDWs) will be generated including soils from test pits, shallow soil borings, deep soil borings, and water from monitoring wells and steam cleaning activities. This subsection describes JMM's approach to handling these IDWs.

4.3.9.2. Test Pit Soils. The soil from test pit excavations will be inspected for UXO and other potentially hazardous materials during the excavation process. As described in Section 4.3.3., the excavated soils will be placed adjacent to the test pit excavation. During the excavation, any UXO or other metallic debris will be removed from the soil pile and placed in a designated UXO holding area. The TEAD EOD team will dispose all UXO. After each excavation has been cleared of UXO and metallic debris, the contents of the soil pile will be used to backfill the test pit from which it originated.

4.3.9.3. Drill Cuttings. Unsaturated conditions are expected at each location where the subsurface soils will be sampled by drilling. Dry cuttings will be inspected for visual contamination and samples and cuttings will be screened using an PID or FID. If no visible contamination is observed and if no elevated levels of organic vapor are detected, the soil cuttings and excess soil from soil samplers will remain at the site. In the shallow borings, auger cuttings, and excess soil samples will be used as backfill material. In the deep (100-foot) soil borings, the cuttings and excess sample from the soil samplers will be spread out onto the ground surface in the vicinity of the borehole. The borehole will be backfilled using a bentonite-cement grout.

4.3.9.4. Saturated soils or soils with visible signs of contamination and/or elevated organic vapor concentrations will be placed in 55-gallon steel drums. The drums will be placed on pallets and temporarily staged at a location designated by N TEAD representatives pending laboratory results of soil samples collected from the same depth intervals.

4.3.9.5. Purged Groundwater From Wells. Purge water collected from monitoring wells will be containerized either in DOT-approved 55-gallon barrels or in other suitable containers. Barrels will be staged at a temporary holding area approved by N TEAD personnel until the groundwater sample analysis results are available. When the results are obtained, a permit for discharge and treatment at the Industrial Waste Treatment Plant will be obtained for disposal.

4.3.9.6. Decontamination Rinse Water. Decontamination procedures are expected to generate significant quantities of rinse water. The rinse water will be captured both at the decontamination pad and at the temporary decontamination stations and containerized in 55-gallon barrels. Up to 17 samples of rinsate will be collected from these barrels and analyzed for explosives, metals, anions, VOCs, SVOCs, and TRPH. These drums will be placed on pallets and staged at a temporary holding area designated by N TEAD personnel pending the laboratory results. After receipt of the laboratory results, a permit will be obtained to discharge and treat decontamination water at the Industrial Waste Treatment Plant.

4.3.9.7. Disposable Sampling Equipment and Personal Protective Equipment. Level D personal protective equipment (PPE) and disposable sampling equipment will be used for most of the field investigations associated with the N TEAD RFI. As this equipment becomes soiled and used, it will be placed in DOT-approved 55-gallon steel drums. Up to five samples of PPE will be collected for analysis of explosives, metals, anions, VOCs, SVOCs, and TRPH. Drums containing disposable sampling equipment and soiled PPE will be placed on pallets and staged in an area designated by N TEAD personnel pending receipt of the laboratory analyses. Handling and disposal of this material will be based on its classification as a hazardous or nonhazardous waste, which will be determined by the analytical results.

4.3.9.8. Hazardous/Non-Hazardous Designation and Waste Disposition. For the purposes of making a hazardous/non-hazardous determination regarding the contents of IDW-filled drums, the results of the TCLP analyses will be used. If there are drums in which the IDW have not been analyzed according to TCLP, the hazardous/nonhazardous determination will be made based on the results of other analyses of the contents by assuming that 100 percent of the contaminants detected in drummed IDW will be leachable. If the results of these calculations indicate that the concentrations of contaminants in soil or PPE exhibit the characteristics of a hazardous waste, the waste will be turned over to the N TEAD EMO for disposal. Conversely, if the results of these calculations indicate that the levels of these contaminants are below the hazardous criteria, the wastes will be disposed of at the sanitary landfill or at another on-Depot location designated by N TEAD representatives.

4.3.10. Facility-Wide Investigations

4.3.10.1. In addition to the SMWU-specific investigations, three other investigations will also be conducted in support of the N TEAD Phase I RFI. These include a groundwater level elevation measurement program, a background soil sampling program, and a field survey program. Each of these additional investigations are discussed in the following paragraphs.

4.3.10.2. Groundwater Elevation Measurements. Two rounds of groundwater elevation measurements will be collected from 48 selected wells and piezometers in all portions of N TEAD and in the areas immediately east and north of N TEAD as shown in Table 4-2. The groundwater measurement rounds will be taken at times that generally correspond to both seasonal high and low groundwater levels. Based on existing hydrographs, it appears that the groundwater levels reach a maximum during June and July and a minimum during December and January. Groundwater level elevations will be measured to the nearest 0.01 feet using an electronic water level meter and referenced to the top of the inside well casing. All measurements will be made during a single 24-hour period to minimize local fluctuations in groundwater elevations. Groundwater elevation data will be reduced and plotted to create water table contour maps for the entire N TEAD facility. These maps will be included in the Phase I RFI summary report.

4.3.10.3. Background Soil Sampling Program. The objective of the background soil sampling program is to develop a data base of background concentrations of metals and anions that is representative of the natural, undisturbed soil at N TEAD. The data base will be used to evaluate whether the metals and anions in soil samples from SWMUs are naturally occurring or the result of a contaminant release.

TABLE 4-2

SELECTED WELLS FOR N TEAD
WATER LEVEL SURVEY

Maintenance Area	Open Revetment Area	Ordnance Area	Outside N TEAD Boundary
B-2	B-1	N-3A	B-40
B-26	B-4	N-3H	B-41
B-54	B-6	N-110-88	B-44
N-112-88	B-7	N-127-88	B-45
N-114-88	B-9	N-128-88	B-47
	B-10	N-130-88	B-48
	B-12	N-131-90	B-53
	B-24	N-132-90	15-387 (private well)
	B-30	N-133-90	No. 8[b]
	B-32	N-137-90	15-406[c]
	A-6	N-138-90	15-408[c]
	N-111-88	N-139-90	15-2377[c]
	N-116-88	WW-4	
	N-118-88	WW-5[c]	
	N-134-90		
	N-135-90		
	N-136-90		
	P-15[a]		
	P-19[a]		
	P-21[a]		

(a) Shallow piezometer
(b) Tooele Water Supply Well
(c) Will be included if possible

4.3.10.4. Soil types at N TEAD have been mapped by the U.S. Soil Conservation Service (USSCS) as shown in Figure 3-4 and summarized in Table 4-3. Using this information, the following procedures will be used to develop the background soil data base:

- Confirm the USSCS soil survey soil type by checking the specific soil type at each SWMU

- Collect five background samples per USSCS soil type from both the surface (approximately 0-1' feet bgs) and shallow subsurface (approximately 1-5' feet bgs) soils, from undisturbed areas for metals, selected anion, and pH analysis

- Drill one deep soil boring to 100 feet in soil representative of the primary soil type in the OB/OD Area and collect seven soil samples for metals, anions, and pH analysis

- Conduct geotechnical grain size and Atterberg Limits on at least one sample from each soil type to verify the USSCS textural classification.

4.3.10.5. Field Confirmation of Soil Types. A review of the existing soil survey for N TEAD and personal communication with the (USSCS) indicates there are five soil mapping units in the investigation areas at N TEAD. As discussed in Section 3 and shown in Table 4-3, the primary soil types found in these mapping units include the Abela, Berent, Hiko Peak, Birdow, and Medburn. Included in these mapping units are inclusions of other soil types that are either intermingled with the main soil type or areally too small to map independently. As a result, the SWMU may be located in an inclusion and not the primary soil type identified by the mapping unit. To insure that the appropriate soil type is identified at each SWMU, a field survey will be conducted prior to sampling and the soil type(s) at each SWMU will be identified. To determine the type of soil at each SWMU, a core sample will be collected using a hand bucket auger sampler or digging a small pit. The soil will be described using the following physical characteristics: Munsell color (wet); percent gravel, sand, and fines; sorting and angularity (coarse-grained material); pH, and cohesiveness. The soil will be classified according the USSCS soil series descriptions as shown in Table 3-1, and the soil texture will be classified using USSCS

TABLE 4-3

SUMMARY OF N TEAD SWMUs AND ASSOCIATED SOIL TYPES

SWMU Numbers	Mapping[a] Unit	Main Soil Type	Possible Inclusions
1	HCD	Hiko Peak	Medburn and Sprager soils
	PAC	Birdow	Erda and Lakewin soils
14	SBC	Medburn	Hiko Peak, Taylorsflat, and Berent soils
4, 19, 20, and 37	HCD	Hiko Peak	Medburn and Sprager soils
21	RGF	Berent-Hiko Peak Complex	Amtoft, Medburn, Sprager, Taylorsflat, Duneland, and Rock Outcrop soils
26, 29, 34, 38, 42, 45, 46, and 47	CAC	Abela	Borvant and Birdow soils

(a) USSCS mapping unit designation, See Figure 3-4.

Taken from USSCS, 1991.

terminology. In addition, a determination will be made whether the SWMU is situated on a site that has been filled or disturbed to the extent the native soil cannot be identified.

4.3.10.6. Surface and Shallow Sub-Surface Soil Sampling Procedures. Soils in semi-arid environments are characterized by high pH values and the accumulation of salts, primarily calcium carbonate. Calcium carbonate precipitates and accumulates in the subsurface soil as a result of evapotranspiration and the lack of precipitation. The depth at which precipitates accumulate varies from soil to soil and is dependent on the depth of percolation of precipitation and the plant community. The type and quantity of metals and ions found in association with the carbonate layer varies and is dependent on the original geologic material and the soil pH. In general, soils in semi-arid environments have basic pH values and the pH values increase as calcium or sodium salts precipitate. As soil pH and the available calcium increases many metals and anions (salts) are immobilized and accumulate in the zone of precipitate. Based on the characteristics of soils in semi-arid environments, two soil samples will be collected from each background soil sampling location. One sample will be collected above the zone of precipitate accumulation, and one sample will be collected at or just below the zone of precipitate accumulation (highest pH). The soil sample collected above the zone of precipitate accumulation (surface sample) should represent the metals and anions that would be present under natural conditions in the N TEAD environment. The shallow subsurface samples collected in the zone of calcium carbonate accumulation should represent the accumulation of metals or anions leached from the surface soil by precipitation.

4.3.10.7. Soil samples will be collected by either digging a small pit or hand augering a bucket auger sampler in the area to be sampled. If a pit is dug, the pit face will be scraped prior to sampling, and the pit will be sampled from bottom to top. If a hand auger is used, the sample will be collected from the sampler. The zone of precipitate accumulation will be identified by an increased pH value, or increased reaction from hydrochloric acid. The surface soil selected for analysis will be collected from the the hand augering bucket sampler or from the pit face using a stainless steel trowel or similar piece of equipment. The surface soil sample should include soil collected from the ground surface to the zone of precipitate accumulation (approximately 0 to 1 feet bgs, dependent on soil type). After the soil is collected it will be homogenized in a stainless steel bowl and then placed in the appropriate sample containers.

4.3.10.8. Shallow subsurface soils (approximately 1 to 5 feet bgs) selected for analysis will be those soils that have the highest pH values (determined by the field test), or the strongest reaction from the hydrochloric acid. The sample will be collected from the pit or hand auger barrel using a stainless steel trowel and will be homogenized in a stainless steel bowl prior to containerization.

4.3.10.9. Deep Soil Boring Sampling Procedures. The sampling objective of the deep soil boring is to provide background concentrations of metals and anions to a depth of 100 feet bgs for a soil that is representative of the the primary soil type found in the OB/OD areas. The deep soil boring drilling and sampling procedures that will be used for this program are outlined in Section 4.3.4. Soil samples from each sample interval will be placed in the appropriate analyte-specific container. A list of sample containers is provided in Section 5, Table 5-4. After the soil boring has been completed, seven samples will be selected for metals and anions analysis. Criteria to be used for sample selection includes the presence of texture changes (i.e., gravel to sand, or sand to clay, etc), organic material, precipitate accumulation, or a buried surface horizon. Because soil texture affects the chemical and hydraulic properties of soil, a sample for each soil texture found in the boring should be selected for analysis. If none of the above criteria are met, the on-site geologist will select the samples from the 5, 10, 20, 35, 50, 75, and 100 foot depth intervals.

4.3.10.10. Documentation. All soil sampling locations will be logged and the information will be placed on a shallow soil boring log form and in the appropriate field log book. The following information will be recorded: date, time, location, sampling personnel, USSCS identification, Munsell soil color (wet); percent gravel, sand, and fines; sorting and angularity (coarse-grained material); pH; hydrochloric acid reaction, and cohesiveness.

4.3.10.11. Field Survey. A topographic field survey will be conducted across N TEAD in advance of the field sampling programs to provide reference locations at each SWMU. All sample collection locations will be tied to the reference locations on the day the sampling activities were conducted. At sites where grids are set up to facilitate sampling (the DRMO Storage Yard and the Drum Storage Areas), the corners of the grids will also be surveyed. In addition, all borings 25 feet or deeper will be surveyed. Survey data will be presented in terms of Utah State plane coordinates, and an accuracy of ±1.0 feet horizontal control and ±0.1 feet vertical control will be considered acceptable.

4.3.10.12. Survey Markers. At locations where test pits in the Propellant Burn Pad and Trash Burial Pits portions of SWMU-1 reveal old burial trenches and pits, permanent survey markers will be constructed to act as a reference locations. These survey markers will be constructed from 6-inch diameter cardboard tubes filled with concrete. The tubes shall extend a minimum of two feet into the ground and extend one foot above ground. After the tube is filled with concrete, a brass cap stamped with a disposal pit designation will be placed in the top of the concrete.

5.0 CHEMICAL ANALYSIS PROGRAM

5.1 SITE-SPECIFIC CONTAMINANTS

5.1.0.1. The types of analyses that will be performed on N TEAD samples are listed in Table 5-1 according to matrix. A complete listing of analytes for each parameter may be found in Appendix E.

5.1.1. USATHAMA and EPA Methods

5.1.1.1. Samples will be analyzed using USATHAMA-certified methods with the exception of three analyses. Dioxins/furans, the gap test, and the internal ignition test are all uncertified methods and will be entered into the Installation Restoration Data Management Information System (IRDMIS) as code "99". Table 5-2 presents the laboratory's USATHAMA method code for each type of analysis and the corresponding EPA equivalent.

5.2 ANALYTICAL PROCEDURES

5.2.0.1. N TEAD Phase I RCRA Facility Investigation (RFI) samples will be analyzed by Environmental Science & Engineering, Inc. (ESE), Gainesville, Florida. ESE is certified by the State of Utah Department of Health Services an environmental chemistry laboratory. Southwest Research Institute (SRI) will perform the explosive reactivity tests (methods uncertified by USATHAMA) on selected samples. A third laboratory, Enseco, will analyze samples for dioxins/furans. The following subsections describe analytical methods, sample containers, preservatives, holding time requirements, and USATHAMA lot assignment procedures.

5.2.1. Analytical Methods

5.2.1.1. Based on a review of the site's operational history and previous investigations and characterizations, the analytical methods listed on Table 5-2 will be used to analyze soil and groundwater samples collected during the RFI. Included in Table 5-2 is a list of the instrumentation used to perform sample analyses. Additional details regarding USATHAMA-certified methods are on file at the laboratory. Analyte lists, certified

TABLE 5-1

ANALYSIS SCHEDULE

Analytes	Soil Samples	Water Samples
Volatile Organic Compounds	X	X
Semivolatile Organic Compounds	X	X
Dioxins/Furans	X	X
Organochlorine Pesticides	X	X
Herbicides	X	X
Total Recoverable Petroleum Hydrocarbons	X	X
Explosives	X	X
Target Analyte List Metals	X	X
Total Cyanide	X	X
Nitrate plus Nitrite	X	X
Chloride and Sulfate	X	X
Phosphates	X	X
Bromide	--	X
TCLP Volatile Organic Compounds	X	--
TCLP Semivolatile Organic Compounds	X	--
TCLP Pesticides	X	--
TCLP Herbicides	X	--
TCLP Metals	X	--
Moisture Content	X	--
Gap test	X	X
Internal ignition test	X	X
pH	X	--

X Analysis to be performed
-- Analysis will not be performed

TABLE 5-2

REFERENCE METHODS FOR SOIL AND AQUEOUS SAMPLES

Parameter	USATHAMA Method Soil	USATHAMA Method Aqueous	USEPA Method Equivalent Soil	USEPA Method Equivalent Aqueous	Method Description
Priority Pollutant Volatile Organic Compounds	LM19	UM20	8240	8240	GC/MS
Priority Pollutant Base/Neutral/Acid (Semivolatile) Extractables	LM18	UM18	8270	8270	GC/MS
Organochlorine Pesticides	LH10	UH02	8080	8080	GC/ECD
Herbicides	LH11	UH14	8140	8140	GC/ECD
Total Analyte List Metals:					
Aluminum	JS11	SS10	6010	200.7	ICP
Antimony	JS11	SS10	6010	200.7	ICP
Arsenic	JD19	SD22	7060	206.2	GFAA
Barium	JS11	SS10	6010	200.7	ICP
Beryllium	JS11	SS10	6010	200.7	ICP
Cadmium	JS11	SS10	6010	200.7	ICP
Calcium	JS11	SS10	6010	200.7	ICP
Chromium, total	JS11	SS10	6010	200.7	ICP
Cobalt	JS11	SS10	6010	200.7	ICP
Copper	JS11	SS10	6010	200.7	ICP
Iron	JS11	SS10	6010	200.7	ICP
Lead	JS11	SD20	6010	239.2	ICP/GFAA
Magnesium	JS11	SS10	6010	200.7	ICP
Manganese	JS11	SS10	6010	200.7	ICP
Mercury	JB01	SB01	7471	245.1	Cold Vapor AA
Nickel	JS11	SS10	6010	200.7	ICP
Potassium	JS11	SS10	6010	200.7	ICP
Selenium	JD15	SD21	7740	270.2	GFAA
Silver	JS11	SD23	6010	200.7	ICP
Sodium	JS11	SS10	6010	200.7	ICP
Thallium	JS11	SD09	6010	279.2	ICP/GFAA
Vanadium	JS11	SS10	6010	200.7	ICP
Zinc	JS11	SS10	6010	200.7	ICP
Sulfate, Chloride	KT05	TT10	300.0	300.0	IC
Nitrite Plus Nitrate	KF10	TF22	modified 353.2	353.2	Technicon
Phosphates	KF14	TF27	modified 365.1	365.1	Technicon
Total Cyanide	KY01	TF18	9010	335.3	Colorimetric
Total Recoverable Petroleum Hydrocarbon (TRPH)	NA	NA	Extract./ 418.1	418.1	IR
Explosives	LW12	UW32	NA	NA	HPLC
Dioxins/Furans	NA	NA	8280	8280	GC/MS
TCLP Parameters					
TCLP Extractions	NA	NS	1311	NS	
TCLP VOAs	NA	NS	TCLP/UM20	NS	GC/MS
TCLP BNAs	NA	NS	TCLP/UM18	NS	GC/MS

TABLE 5-2

REFERENCE METHODS FOR SOIL AND AQUEOUS SAMPLES
(CONTINUED)

Parameter	USATHAMA Method Soil	USATHAMA Method Aqueous	USEPA Method Equivalent Soil	Aqueous	Method Description
TCLP Pesticides	NA	NS	TCLP/UH02	NS	GC
TCLP Herbicides	NA	NS	TCLP/UH14	NS	GC
TCLP Metals (a)	NA	NS	TCLP/SS10/SB01	NS	ICP/Cold Vapor AA
Explosive Reactivity Tests	NA	NS	Bureau of Mines	NS	Physical
pH	NA	NS	9045	NS	Electrometic

(a) Arsenic and selenium will be reported as uncertified analytes, based on ICP quantitation.

NS Indicates analysis not scheduled for this matrix.
NA Not applicable
ICP Inductively coupled plasma
GC/MS Gas chromatography/mass spectroscopy
GC/ECD Gas chromatography/electron capture detector
IC Ion chromatography
HPLC High pressure liquid chromatography
IR Infrared spectrometry
GFAA Graphite furnace atomic absorption
AA Atomic absorption
TCLP Toxicity Characteristic Leaching Procedure

reporting limits (CRL), upper control range (UCR), and the average accuracy over the certified range of the method (slope) are included in Appendix E.

5.2.2. Sample Containers and Holding Times

5.2.2.1. Sample container requirements and maximum acceptable sample holding times are presented in Table 5-3 for soil samples and Table 5-4 for water samples. Sample containers will be supplied by a commercial vendor that meets USATHAMA's cleaning requirements. Groundwater and surface water containers will be triple rinsed with sample water prior to filling. Preservatives will be added to samples after containers have been filled. Sample containers will be filled completely to obtain a sufficient volume of sample material.

5.2.3. Lot Assignments

5.2.3.1. The reporting of analytical results to the USATHAMA IRDMIS requires that each sample aliquot be assigned a unique six-character identification. The first three characters of this identification are alphabetic characters that represent the analytical lot. The last three characters are numeric characters that represent the individual samples within the lot. A lot is the maximum number of samples, including Quality Control (QC) samples, that can be manually processed (extracted, analyzed, or digested) through the rate limiting step of the method. Samples will be placed into lots based on analysis and matrix type. Lot sizes will be equal or less than the size approved for the method by USATHAMA.

5.3 LABORATORY DATA REPORTING

5.3.1. Sample Identification

5.3.1.1. According to USATHAMA requirements, the laboratory assigns a six-character sample identification number to each sample. A complete discussion of sample identification numbers is presented in the Data Management Plan which was prepared as a companion document to this DCQAP. In addition, an overview of the identification codes is included here. The first three characters (log number) are letters that indicate analytical lot (batch). The last three characters (sample analysis number) will be numbers assigned in sequential order to indicate the instrumental analysis order within

TABLE 5-3

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR SOIL SAMPLES

Analytical Parameter	Container	Preservative	Holding Time
EXTRACTABLE ORGANICS[(a)]:	One 8-oz wide mouth jar, with Teflon-lined lid	Store at 4°C in dark	
Semivolatiles, Pesticides, and Herbicides			Extract in 7 days/analyze in 40 days
Explosives			Extract and analyze in 56 days
TRPH			28 days
DIOXINS/FURANS	One 8-oz wide mouth jar, with Teflon-lined lid	Store at 4°C in dark	Extract in 30 days, completely analyze in 45 days
VOLATILE ORGANIC COMPOUNDS	Two 120-ml vials with Teflon-lined septa, completely filled	Store at 4°C in dark	14 days
INORGANICS	One 8-oz wide-mouth jar, with Teflon-lined lid	Store at 4°C in dark	
Metals			6 months
Mercury			28 days
Cyanide			14 days
Anions [(b)]			28 days
Explosive Reactivity Test		Store in dark	
Gap Test			
Internal Iginiton Test			

TABLE 5-3

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR SOIL SAMPLES (CONTINUED)

Analytical Parameter	Container	Preservative	Holding Time
TCLP PARAMETERS (c)	Three 8-oz wide mouth jars, with Teflon-lined lids	Store at 4°C in dark	
TCLP VOAs			TCLP extract in 14 days, analyze in 14 days
TCLP BNAs			TCLP extract in 14 days, prep extract in 7 days, and analyze in 40 days
TCLP Pesticides			TCLP extract in 14 days, prep extract in 7 days, and analyze in 40 days
TCLP Herbicides			TCLP extract in 14 days, prep extract in 7 days, and analyze in 40 days
TCLP Metals			TCLP extract in 6 months, analyze in 6 months
TCLP Mercury			TCLP extract in 28 days
pH	4-oz wide mouth jar with Teflon-lined lid	Store at 4°C in dark	Analyze in 7 days

(a) Includes semivolatiles (BNAs), pesticides, herbicides, TPH-IR, and explosives. Dioxin/furan samples require separate containers.
(b) Anions include sulfate, chloride, nitrite plus nitrate, and phosphate.
(c) TCLP: Toxicity Characteristic Leaching Procedure

TABLE 5-4

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR WATER SAMPLES

Analytical Parameter	Container	Preservative	Holding Time
Semivolatile Compounds	Three, 1-L amber glass bottles with Teflonlined lids	Store at 4C in dark	Extract in 7 days/analyze in 40 days
Organochlorine Pesticides	Three, 1-L amber glass bottles with Teflon-lined lids	Store at 4C in dark	Extract in 7 days/analyze in 40 days
Herbicides	Three, 1-L amber glass bottles with Teflon-lined lids	Store at 4C in dark	Extract in 7 days/analyze in 40 days
Explosives	Two, 2-L amber glass bottles with Teflon-lined lids	Store at 4C in dark	Extract and analyze in 56 days
Dioxins/Furans	Two, 1-L amber glass bottles with Teflon-lined lids	Store at 4C in dark	Extract in 30 days, completely analyze in 45 days
Volatile Organic Compounds	Four, 60-ml vials with Teflon lined septa, filled completely	Store at 4C in dark HCl to pH <2	14 days
Metals[a]	One, 1-L plastic bottle	HNO3 to pH<2	6 months
Mercury[a]	Sample drawn from metals bottle	HNO3 to pH<2	28 days
Total Cyanide	One, 1-L plastic bottle	Store at 4C, NaOH to pH>12	14 days
TRPH	One, 1-L glass bottle	Store at 4C, H2SO4 to pH<2	28 days
Anions[b]	One, 1-L plastic bottle	Store at 4C	28 days - Sulfate 28 days - Chloride 28 days - Bromide
Nitrite plus Nitrate	One, 1-L plastic bottle	Store at 4C, H2SO4 to pH<2	28 days - Nitrite plus Nitrate
Phosphates	Sample drawn from nitrite plus nitrate bottle	Store at 4C, H2SO4 to pH<2	28 days - Phosphates

(a) Samples will be filtered in the field prior to preservation.
(b) Anions include sulfate, chloride, bromide, nitrite plus nitrate, and phosphate.

the lot. All reported sample results will bear these unique numbers in addition to laboratory numbers. Laboratory numbers will not be allowed to substitute for these special sample identification numbers.

5.3.2. Certified Compounds

5.3.2.1. Sample results for target compounds/analytes will be reported in accordance with USATHAMA Data Management requirements using the IRDMIS software. Compounds will be entered using code names and designated codes to identify unique analytical requirements, such as spiked compounds, quality control samples, blanks, etc. Upon completion of data entry, the data will be reviewed by the analytical supervisor, analytical task manager, and QA staff. Additional QA checks are performed by the ESE data management system.

5.3.3. Unknowns and Noncertified Compounds (GC/MS Methods Only)

5.3.3.1. For GC/MS methods, unknown compounds will be identified by relative retention time. Compounds that can be identified with greater than 95 percent certainty (purity fit) will be reported to the IRDMIS using the USATHAMA test name code and a flagging code "S". For unknowns that cannot be identified with greater than 95 percent certainty, the results will be entered into the IRDMIS as unknown (UNK) XXX, with flagging code "S", where XXX is the relative retention time (RRT) of the unknown. Tentative identification of these compounds will be provided when or before the data are sent to IRDMIS. For volatile compounds, XXX is calculated in relation to the retention time of 1,2-dichloroethane-d4 (100 times RRT = XXX). For semi-volatiles, XXX is calculated as 100 times the relative retention time with respect to phenanthrene-d10, plus 500. No semi-volatile XXX will be less than 500.

5.3.3.2. Noncertified compounds are those not contained in the laboratory method certification list (Appendix E), but are contained in EPA Target Compound List (TCL). If a noncertified compound is detected at or above the detection limit, JMM will require that the laboratory enter into the IRDMIS the compound test name, calculated value, and a flagging code of "S". If a noncertified compound is not detected, the data will be entered into the IRDMIS using the compound test name, an "ND" (nondetected) boolean, the detection limit value, and a flagging code of "R". If the compound is detected, but at less than the detection limit, the data shall be entered into the IRDMIS in the same manner as a nondetect. However, the calculated value will be recorded in the lot data package.

5.3.4. Hard Copy Results

5.3.4.1. Sample results obtained from the instrument will be retained in the laboratory. The raw data will be packaged in lot packages with each containing all documentation for tracking and analyzing samples in the laboratory. A typical analytical report will be generated with all the chemical results for submission to JMM. These reports will accompany the lot transfer files prior to Level 3 elevation.

5.4 DATA REDUCTION, VALIDATION, AND REPORTING

5.4.0.1. Accurate data reduction, validation, and reporting methods are essential in summarizing information to support conclusions. Proper techniques for both field and laboratory activities are described in this section.

5.4.0.2. Data reduction methods can include the computation of summary statistics, their standard errors, and confidence intervals or limits. Field and laboratory data reduction techniques are presented in 5.4.1 and 5.4.4, respectively.

5.4.0.3. Data validation techniques include screening, accepting, rejecting, or qualifying data on the basis of sound criteria. Data validation is based on the following criteria:

- Initial calibration
- Continuing calibration
- Holding times
- Blank sample results
- Other QC sample results.

5.4.0.4. Data values that are significantly different from the population are referred to as "outliers". A systematic effort will be made to identify any outliers or errors prior to reporting data. Outliers resulting from errors found during data validation will be identified and corrected. Those that cannot be attributed to analytical, calculation, or transcription errors will be retained in the data base for further evaluation. The validation methods for field and laboratory activities are presented in 5.4.5 and 5.4.6.

5.4.0.5. Data reporting for both field and laboratory efforts are described in Sections 5.4.7 and 5.4.8.

5.4.1. JMM Field Data Reduction

5.4.1.1. No data reduction will be necessary for field chemical and physical measurements. All readings will be recorded directly from the instruments. The following units will be used when recording the data:

- Water Levels: Reported to the nearest 0.01 feet after two measurements agree.
- Water Temperature: Reported to 0.1 degree unit (centigrade).
- pH: Digital reading rounded to 0.1 pH units.
- Specific Conductivity: Reported to 100 micromhos per centimeter.
- Survey Data: Well casing elevations surveyed to 0.01 feet; coordinates to 1.0 feet.

5.4.1.2. Field data will be entered into the appropriate IRDMIS data files.

5.4.2. Dames and Moore Geotechnical Data Reduction

5.4.2.1. As discussed in Section 4.0, approximately 10 percent of the soil samples collected during field investigation will be subjected to geotechnical grain size testing. The geotechnical laboratory will report soil grain sizes in terms of percentages of each of the major USCS classes (i.e., clay, silt, sand, gravel) and based on the results, assign a USCS classification. The laboratory soil classifications will be used to verify or edit descriptions made in the field by JMM's on-site geologists. Edited soil classifications will be presented on the final test pit and soil boring logs. There is currently no method for entering geotechnical data into the IRDMIS.

5.4.3. Geophysical Survey Data Reduction

5.4.3.1. Data collected during the geophysical survey will be validated by the geophysical subcontractor and checked for accuracy by JMM's field operations leader while still in the field. Since the geophysical investigations will be used to confirm the locations of old open burning and burial pits, geophysical data will consist of two general types of measurements; those indicative of background conditions (i.e., in undisturbed areas) and those indicating anomalies (i.e., where buried materials may be present). The geophysical surveys will be conducted along traverses beginning at background locations across burial pits terminating in background conditions. Geophysical data will be plotted along profiles that will show background readings and anomalous readings over the old burial pit locations. Discussions of instrument calibration techniques and operations are included in Section 4.0. There is currently no method for entering geophysical data into the IRDMIS.

5.4.4. Laboratory Data Reduction

5.4.4.1. Laboratory data will be reduced according to USATHAMA protocols, as described in each of the analytical methods. All numerical results will be reported in terms of concentration in the environmental sample. Concentrations will not be adjusted prior to entry with the IRDMIS and reporting to USATHAMA. Correction factors (e.g., accuracy, percent moisture, and dilution factor) are maintained separately in the IRDMIS. Only sample concentrations measured within the certified range, prior to correction, will be reported. The correct number of reported significant figures, by method certification type, are as follows:

- Class 1 and 1B - 3 significant figures
- Class 1A - 2 significant figures
- Class 2 - 2 significant figures.

The number of significant figures will be reduced if a sample requires dilution, as described in the USATHAMA Quality Assurance (QA) Manual. All uncorrected sample results less than the CRL, including no response, will be reported as "less than" the reporting limit.

5.4.4.2. Following data validation, both field and laboratory data will be reported according to procedures described in the following sections.

5.4.5. Field Data Validation

5.4.5.1. Field personnel will validate field data (pH, specific conductivity, temperature, soil sample location references, and soil descriptions) through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved immediately, if possible, by seeking clarification from those personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in the Data Collection Quality Assurance Plan (DCQAP) to ensure that defensible and justifiable data are obtained. IRDMIS group and record checks will be performed on field data prior to uploading field data to Potomac Research Institute (PRI). Additional checks will be performed at PRI.

5.4.6. Laboratory Data Validation

5.4.6.1. Laboratory data collected from N TEAD Phase I RFI will be validated by four different organizations, with each organization evaluating a different aspect of the data. Primary data validation activities will occur within the laboratory prior to transfer of the data to the USATHAMA data management system. Additional validation will occur through reviews performed by the USATHAMA Chemistry Branch, JMM, and PRI. The following subsections describe the specific activities of the validation steps.

5.4.6.2. **Analytical Laboratory.** All analytical data generated by the laboratory are reviewed by the analyst supervisor, analytical task manager, and the QA staff. In addition, QC checks are performed by the ESE data management system. These checks include flagging samples that were analyzed outside the holding time.

5.4.6.3. Once the analyst has completed the analyses for a "lot" of samples, a USATHAMA lot folder is prepared and submitted to the data management center. The data coordinator finalizes the results in the ESE data batch and incorporates the remaining information into the lot folder. The laboratory review chain then continues with the department manager or group leader review of the lot folder. Finally, the project manager reviews the lot prior to QA validation. The Army Data review form is filled out upon completion of each step of the review.

5.4.6.4. The laboratory project QA staff is responsible for reviewing and approving all data packets before transmitting data to USATHAMA for entry into IRDMIS. Validation involves a thorough review of the data documentation from reported results to raw data including recalculation of results of a selected subset of data. Any changes to the data are documented on the formal review sheets so that the appropriate flags are incorporated in the USATHAMA lot file.

5.4.6.5. Audits are performed on every data lot to ensure that all QC checks required by the method are performed and acceptable. The use of a method specific data review checklist ensures that a thorough lot folder audit is performed. This audit includes checking of the control charts, method blanks, standard matrix recoveries, surrogate recoveries, calibration curves, certified reporting limits, and units. Also included in the reviews are analysts' notebook pages, numbers of samples and identifications, dilutions, moisture content, sample weights, chain-of-custody records, standard preparation notebooks, instrument logbooks, etc. After ensuring that all these items on the method specific inventory are presented and complete, selected data values are verified. Several lines of data in the IRDMIS transfer file are selected by the random number generator according to MIL-STD-105D, April 29, 1963. One line of data represents one data point. The chosen data points are then traced back to the raw data to verify correctness.

5.4.6.6. Any discrepancies pertaining to any of the previously mentioned audits are directed to the analytical project manager for verification, clarification, and/or correction. Other queries regarding the data transmission file are addressed directly to data management.

5.4.6.7. USATHAMA Chemistry Branch. The laboratory will submit control charts for every analytical lot to the USATHAMA Chemistry Branch for review and approval on a weekly basis. The Chemistry Branch, through review of the control charts, will determine if analyses are in control. If problems are identified through this review, the Chemistry Branch may require additional information from the laboratory, reanalysis of samples, or qualification of the data.

5.4.6.8. JMM. Concurrent with the control chart review, JMM will perform a general review of sample information and chemical results. This review, which will occur prior to elevating to Level 3, will address the following:

- Field sample information (e.g., sample depth, collection date, etc.) is correct on laboratory reports

- Field QC results are reasonable

- Sample results are reasonable and comparable to historical data.

The laboratory will be notified of any discrepancies identified through this review. Once this review is complete and findings have been incorporated by the laboratory, data will be uploaded to the USATHAMA's data management contractor (PRI).

5.4.6.9. IRDMIS Group and Record Check. After each data packet has been reviewed by key individuals and validated by QA staff, the electronic data file for the packet is loaded by the laboratory into the USATHAMA IRDMIS system at ESE and is run through a record check and then a group check. Every data point is checked using these two routines. IRDMIS record check determines the following:

1. Data are correctly formatted.

2. Laboratory is certified for method on date of analysis.

3. File name (such as CGW, CSW) and site type (BORE, WELL) combinations are valid.

4. Sample date, preparation/extraction date, and analysis data are compared to determine any holding time violations or inconsistencies.

5. All test names are valid for the method.

6. Values comply with Certified Reporting Limits and Upper Certified Limits or are diluted within range.

IRDMIS group check determines the following:

1. The existence of all station identifications for the lot data in the map file for the appropriate installation.

2. All test names/analytes found in the QC are present in all the samples.

3. That all required QC spikes exist, and that all spiking levels are valid, as determined by the methods table, and that no aberrations exist in QC or sample data.

5.4.6.10. If any errors are found in group and record check which are not addressed on the lot cover sheet by the laboratory analysts, laboratory project coordinator manager, or the QA coordinator, the lot is returned to the laboratory analytical task manager so that the problem can be rectified. If changes to the analytical data are required, the lot is then resubmitted to the laboratory QA department. After re-validation, it is again processed through IRDMIS to assure that any errors have been corrected. Comments affecting the quality of data will be associated with each data point as necessary by the use of flagging codes. These codes will be part of the official database.

5.4.6.11. After the data in a lot have successfully passed QA validation and IRDMIS record and group checks, a transfer file of the lot is created and sent to USATHAMA via telephone line. The data are again run through record and group checks by PRI, and after passing the data checks, are elevated to Level 2.

5.4.7. Field Data Reporting

5.4.7.1. Field data, recorded during the sampling activities, will be reduced to tables or arrays for review and verification. Once verified, the data will be compiled and reported in summary tables. Correct codes and/or units will also be provided to accurately reflect the field conditions. Field data will be reported and available for use once it is elevated to Level 3.

5.4.8. Laboratory Data Reporting

5.4.8.1. Data will be considered acceptable for its intended uses once all data validation activities are complete, and data are elevated to Level 3. Data reports will be generated from IRDMIS and will be included in an appendix of the RFI report. In addition, data summary tables that will be included in the body of the RFI report will be generated based on electronic files provided by the laboratory. Electronic transfer will limit the possibility transcription errors, yet will allow flexibility in the reporting format. Slight differences will exist between the IRDMIS and the laboratory data files due to rounding errors inherent in IRDMIS.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

6.0.0.1. This section will describe the data quality objectives (DQO) for this project and the quality control procedures that will be used to assure high quality data are collected.

6.1 DATA QUALITY OBJECTIVES

6.1.0.1. Data quality objectives are qualitative and quantitative statements developed by data users to specify the quality of data needed from a particular data collection activity to support specific decisions or regulatory actions. The three-stage process for developing DQO, as described in USEPA guidance (USEPA, 1987), is based on:

- Identifying the objectives of the projects
- Specifying the data necessary to meet project objectives
- Describing the methods that will yield data of acceptable quality and quantity to support the required decisions.

6.1.0.2. The results of the first two stages of the DQO development process are presented in the DCQAP. Results of the third stage are the basis for preparing this section and include specifying appropriate field techniques; analytical level and methods; and measurements objectives. Field techniques are described in the DCQAP, and the remaining topics are discussed below.

6.1.0.3. Critical indicators of project data quality are precision, accuracy, representativeness completeness, and comparability (PARCC). Objectives for these indicator parameters were developed based on the objectives of this RFI and USATHAMA analytical program quality assurance objectives. Field procedures, analytical methods, and the project QA program were selected and developed to meet these objectives. Table 6-1 provides a summary of the PARCC criteria and types of QC samples used to meet the DQO.

TABLE 6-1

QUALITY CONTROL SAMPLE EVALUATION IN TERMS OF PARCC CRITERIA

PARCC Element	QC Sample Type	Evaluation Criteria
Precision	Field Duplicate Pairs	Relative Percent Difference
Accuracy	Matrix Spike Matrix Spike Duplicate Surrogate Spikes	Percent Recovery
Representativeness	Equipment Blanks Trip Blanks Field Duplicates	Qualitative, Degree of Confidence
Completeness	Holding Time Valid Data	Holding Time Limits Percent Valid Data*
Comparability	Standard Analytical Methods Standard Units of Measure Field Duplicate Results	Qualitative, Degree of Confidence

$$* \text{ Percent Valid Data} = \frac{\text{number of valid data points}}{\text{total number of measurements}} \times 100$$

6.1.1. Precision

6.1.1.1. Precision refers to the reproducibility of measurements of the same characteristics, usually under a given set of conditions. For large data sets, precision is expressed as the measure of variability of a group of measurements compared to their average value (i.e., standard deviation). For duplicate measurements, precision is expressed as the relative percent difference (RPD) of the pair and is calculated using the following equation:

$$\mathrm{RPD} = \frac{|A\text{-}B|}{([A+B]/2)} \times 100$$

where: A and B are the reported concentrations for sample duplicate analyses.

6.1.1.2. Analytical precision is maintained in the laboratory through the analysis of control samples spiked with either surrogate or target analytes. Precision of GC/MS methods is evaluated by comparing the control sample surrogate recoveries to previous recoveries. Results are plotted on a 3-point moving accuracy and precision control chart. Precision of non-GC/MS methods is evaluated by comparing duplicate control samples analyzed within the same analytical lot. Results for these methods are plotted on single day and three day control charts. The procedures discussed in Sections 5, 11, and 14 of the *USATHAMA Quality Assurance Program Plan* (USATHAMA, 1990) will be used to establish analytical precision control limits for this project.

6.1.1.3. Precision will also be evaluated through the analysis of duplicate field samples and matrix spike/matrix spike duplicate samples. Information from these field QC samples will be used to interpret field sample results; however, strict acceptance criteria will not be placed on these sample results.

6.1.2. Accuracy

6.1.2.1. Accuracy refers to the degree of agreement of a measurement to the true value. The accuracy of a measurement system is reduced by errors introduced through all stages of the sampling and analysis. Analytical accuracy will be evaluated and controlled on the basis of laboratory control sample recoveries as described in Sections 5, 11, and 14 of the *USATHAMA Quality Assurance Program Plan*. The laboratory will submit accuracy control charts to USATHAMA on a weekly basis. Matrix-specific accuracy information will be obtained through the analysis of field samples spiked with surrogate and target analytes. Spiked field sample results will not be used to control methods. Instead results will be used to interpret field sample results. The following equation will be used to determine accuracy:

$$\% \text{ Recovery} = \frac{\text{Measured Spike Value - Unspiked Value}}{\text{Known Spike Value}} \times 100$$

6.1.3. Representativeness

6.1.3.1. Representativeness is a qualitative expression of the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is maximized by ensuring that the number and location of sampling points and sample collection and analysis techniques are appropriate and will provide information that reflects "true" site conditions. This DCQAP presents the procedures that will generate representative data. Further representativeness will be evaluated on the basis of several different types of blank samples. These blank samples include method blanks, VOC trip blanks, equipment rinsate blanks, and filter blanks. The objective for these samples, with the exception of soil method blank samples, is that they do not contain measurable concentrations of contaminants of concern. Soil method blank samples are expected to contain background levels of inorganic analytes. Field sample results will be qualified if positive blank sample results are obtained.

6.1.4. Comparability

6.1.4.1. Comparability is a qualitative parameter that expresses the confidence that one data set may be compared to another. This goal is achieved through the use of standardized techniques to collect and analyze samples and appropriate units to report analytical results. These techniques are described in this DCQAP. Due to overlap of the analyte lists for several of the methods, it will be possible to compare analyte concentrations obtained from separate analytical methods. Specifically, chlorinated pesticides and explosives will be measured by two methods each. Both classes of compounds will be measured by the semivolatile GC/MS method. Lower limits of detection of pesticides and explosive compounds will be obtained through gas chromatography (GC) analysis and high performance liquid chromatography (HPLC) analysis, respectively.

6.1.5. Completeness

6.1.5.1. Completeness is defined as the percentage of measurements that are judged valid. The project completeness value will be determined at the conclusion of the data validation phase and will be calculated by dividing the number of complete sample results by the total number of sample analyses listed in the DCQAP. Complete results are defined as results that meet all QC criteria, such as sample holding times and laboratory control sample recoveries. Incomplete results may be used as part of the RFI; however, qualification of the data will be required.

6.1.5.2. The completeness objective for non-critical samples is 90 percent for this project. This objective is greater than the national average completeness percentage for remedial investigations; existing information indicates that Contract Laboratory Program (CLP) data packages are generally 80 to 85 complete (USEPA, 1987). The completeness objective for background samples, as defined in this DCQAP, is 100 percent.

6.2 LABORATORY QUALITY CONTROL SAMPLES

6.2.1. Method Blank Samples

6.2.1.1. Method blanks are ultrapure water samples that contain all the reagents and have been through the processing steps necessary for an analytical procedure. These blanks serve to measure the contamination from the laboratory water, instrument, reagents, and sample processing steps. A method blank aids in distinguishing low level field contamination from laboratory contamination.

6.2.2. Standard Matrix Spikes

6.2.2.1. Control samples will be introduced into the train of actual samples to monitor the performance of the analytical system. Control samples will consist of spiked standard matrix samples and blanks. Standard samples for soil analysis consist of samples of an approved uncontaminated soil obtained from USATHAMA. Results from spiked standard matrix samples will be used to construct control charts to monitor variations in the precision and accuracy of routine analyses. The specific type and number of control samples and the construction of control charts required for USATHAMA are summarized in Table 6-2.

6.2.3. Matrix Spike and Matrix Spike Duplicate Samples

6.2.3.1. A matrix spike (MS) and matrix spike duplicate (MSD) are not required by USATHAMA but are requested. An MS and MSD will be analyzed at a minimum rate of 1 MS and 1 MSD per 20 environmental samples of the same matrix (aqueous versus solid). The MS/MSD will be spiked with the same target compounds that are used to spike the standard matrix. The recoveries of the MS/MSD in the sample matrix are then reported to the database and are used to help interpret the analytical results. Typically, if the recoveries of the standard matrix spike are within precision and accuracy criteria, the method is considered "in control". Recoveries of target analytes in the MS/MSD that are much higher or lower than the accuracy or precision criteria typically document that the analytical method is not totally applicable to that sample matrix. For example, if the MS/MSD recoveries for a sample matrix were below criteria, then the analytical results for the samples in that batch would be interpreted as estimated low due to matrix effects.

6.2.4. Surrogate Spikes

6.2.4.1. Certain methods require the use of surrogates to help monitor method performance (VOCs, SVOCs, pesticides, herbicides, and dioxins/furans). When surrogates are required, they are spiked into all environmental samples, QC samples, and method blanks. The surrogates serve two main functions in the GC/MS methods, to control the method and to document the recoveries of compounds similar in chemical composition to the target compounds. The recoveries of the surrogates in the standard matrix spike analyzed with each analytical lot are plotted on $\bar{X}$ and R control charts (control charts are discussed in Section 6.2.5.). If any point on any of the surrogate control charts are outside criteria, either an acceptable explanation must be provided or the analytical lot will have to be reextracted and reanalyzed. Control charts are not prepared for the surrogates in the environmental samples.

TABLE 6-2

QUALITY CONTROL REQUIREMENTS BY SAMPLE LOT

Requirement	Analytical Control Limits
Control Samples - Non-GC/MS Methods	At least one standard matrix method blank for each daily lot.
	Three standard matrix control spikes at approximately X, 10X, and 10X, where X is the CRL per daily lot.
Control Samples - GC/MS Method	At least one standard matrix method blank for each daily lot spiked with deuterated surrogate standards at the 10X level.
	Each sample spiked with deuterated surrogate standards spiked at approximately 10X, where X is the concentration in the matrix corresponding to the CRL.
Control Charts - Non-GC/MS	Plot average percent recovery value ($\bar{X}$) obtained from the duplicate 10X spikes within each lot for the accuracy control chart.
	Plot differences (R) between the percent recovery values of the duplicate 10X spikes within each lot for the precision control chart.
	Plot 3-point moving average percent recovery values ($\bar{X}$) obtained from the X single spikes within each lot for the moving average accuracy control chart.
	Plot 3-point moving differences (R) of percent recovery values of the X single spike within each lot for the moving average precision control chart.
Control Charts - GC/MS Methods	Plot 3-point moving average percent recovery values ($\bar{X}$) obtained from the single 10X standard matrix spike within each lot for the moving average accuracy control chart.
	Plot 3-point moving differences (R) of the percent recovery values of the single X spike within each lot for the moving average precision control chart.

Source: ESE (1990)

6.2.4.2. The recoveries of the surrogates in the sample matrices are reported to the database and are used to help interpret the analytical results. Typically, if the recoveries of the standard matrix spikes are within precision and accuracy criteria, the method is considered "in control". Sample surrogate recoveries that are much lower or higher than the accuracy or precision criteria typically document that the analytical method is not totally applicable to that sample matrix. For example, if all the acid surrogate recoveries for a sample matrix were below criteria, then the analytical results for the acid extractable target compounds would be interpreted as estimated low due to matrix effects.

6.2.5. Control Charts

6.2.5.1. Control Spikes and Charts for GC/MS Methods. The results of MS and MSD when required, will be reviewed in conjunction with the standard MS, surrogate, and other QC information to aid in determination of the usability of the data. A single control spike of surrogates per lot into standard matrix will be the basis for laboratory control of GC/MS methods. The spike level will normally be 10X, where X is the initial target level. The exact level to be used for the three surrogates in the volatiles method and the four surrogates in the semi-volatiles method will be supplied by USATHAMA and included in the certification package. All actual samples will also be spiked with the same surrogate spiking solutions, but the recovery of surrogates from actual samples will not be used for control purposes. The recovery of surrogates from actual samples may be used by USATHAMA at a later time to assess matrix effects.

6.2.5.2. The percent recovery for each surrogate in the standard matrix spike will be used for control purposes rather than actual concentration.

6.2.5.3. Since there is only one control sample per lot, normal $\bar{X}$ and R (average and range) charts cannot be used. A 3-point moving accuracy and precision control charting approach will be used. Thus, the required replication is achieved across lots rather than within each lot. During certification, two standard matrix samples are spiked with surrogates at 10X and analyzed on a single day. After one lot has been analyzed, three values will be available, two from certification, and one from the first lot. These three values can then be averaged and the first value of $\bar{X}$ obtained. Similarly, the difference between the highest and lowest will give the first value of R. These values will be the first values plotted on the moving accuracy and precision control charts and will be plotted versus the date of the first actual sample lot analyzed.

6.2.5.4. Once the second lot is analyzed, a fourth value for percent recovery will be available. This value will be averaged with the values from the second certification value and Lot 1 of actual analysis to obtain the second value for X. The second value for R will be obtained by the difference between the highest and lowest among these three values. These values will then be the second plotted points on the moving average accuracy and precision.

6.2.5.5. Similarly, after the third lot is analyzed, the percent recovery for this lot is averaged with the individual percent recovery values from the first and second lots to obtain the third value of X; the difference between highest and lowest in this set of three is used to obtain the third plotted point for R. This procedure is continued throughout the project.

6.2.5.6. After the third point is plotted on the control charts, the analyst will continue calculating the mid-line and control limits and assessing whether laboratory performance is in control. It should be emphasized that the averages plotted on the charts, rather than the individual values, will be used to calculate these limits. The step-by-step procedure for calculating these limits is presented in the 1985 USATHAMA QA Program Plan (USATHAMA, 1985).

6.2.5.7. All data will be plotted, whether the lot is in control or not. Each individual value will be tested as an outlier using Dixon's test at the 98 percent confidence limit. If one of the individual points is an outlier, it will not be used in calculating the 3-point moving average, but is excluded from the establishment of control limits after 20 in-control data points.

6.2.5.8. At this point, the control limits should have stabilized and these limits will be used as the basis for determining whether analysis is in control for the next 20 lots. After 40 points are plotted, all 40 values will be used to recalculate the control limits for the next 20 analysis lots. This procedure will be continued for each set of 20 lots. All values will be included in these calculations unless a systematic error was detected for one of the lots that goes into that average value.

6.2.5.9. Control Spikes and Charts for Non-GC/MS Methods. Three spiked standard matrix samples will be included in each lot. The exact levels used for each analyte will be supplied by USATHAMA and included in the certification package. In general, however, each lot will contain two spikes at the 10X level (where X is the CRL obtained during certification), one spike at approximately 2X for that analyte, and one spike at approximately 5X in a natural matrix per analytical lot.

6.2.5.10. Two different types of control charting approaches will be used for non-GC/MS methods. The first approach will be used for recovery of the 10X spikes where there is replication within each lot. The second approach will be used for the recovery of the 2X spikes and will be similar to the approach used for the GC/MS methods where no within-lot replication was available.

6.2.5.11. For the recovery of 10X spikes, an average value (X) will be obtained from the duplicate within each lot, and this value will be plotted versus the date for that lot on an accuracy chart. The difference between this replicate will be obtained and plotted on the precision chart versus the date of analysis for that lot.

6.2.5.12. Initial certification did not use replicate spikes for 10X on each day. Rather, individual percent recovery data are available on each of four days. These data will be used as follows to begin control charts. The percent recovery from certification Days 1 and 2 will be averaged to get the first value of the control charts. The percent recovery values for Days 3 and 4 will be used to obtain the second points to be plotted. Percent recovery values, from the first lot of actual samples, will be used to obtain X and R values, and these values will be the third plotted points on the control charts.

6.2.5.13. After the first actual lot of analysis, control limits will be obtained as described in the 1985 USATHAMA QA Program Plan. These values will be updated after each in-control lot for the first 20 lots.

6.2.5.14. All recoveries will be plotted, whether or not the lot is in control. Each individual value will be tested as an outlier using Dixon's test at the 98 percent confidence level. If the datum is considered an outlier, it will not be used in calculating the control chart limits after 20 in-control data points.

6.2.5.15. As described in Section 6.2.5.1., these control limits should have stabilized at this point and will serve for control purposes for the next 20 lots. Control limits will then be updated after every 20 lots as described previously.

6.2.5.16. Control charts for the percent recovery data from the 2X spikes will be handled using the same moving average control charting method described for the GC/MS methods. The only difference will be the manner in which the certification data are used to provide the initial data for the charts.

6.2.5.17. For these four methods, four individual values for percent recovery were obtained for X during certification. The first three days will be used to obtain the initial plotted points for moving accuracy and precision control charts. Days 2, 3, and 4 will be used to obtain the second plotted point for moving accuracy and precision control charts. After the analysis of the first lot of real samples, the percent recovery for the 2X level spiked sample will be combined with Days 3 and 4 of certification to obtain the third plotted point. Control limits will then be obtained using the step-by-step procedure given in the 1985 USATHAMA QA Program Plan and updated daily until 20 points are plotted. The same approach described previously will be used to update control limits after each new set of 20 lots is analyzed.

6.2.5.18. If the QC requirements presented in Table 6-2 are applied to non-GC/MS methods, at least three control samples will be run with each daily lot of samples.

6.2.5.19. The Project QA Staff may monitor the introduction of the control samples into analytical lot prior to analysis. Subsequent to analysis, the Project QA Staff reviews and approves all control sample data by USATHAMA lots before the results are transmitted to USATHAMA as Level 1 data. Chemical data for each analytical lot which pass QC criteria are automatically entered into the appropriate chemical analysis file for transmission to USATHAMA. The QC results for the QC control samples also are included in the format required by the IR Data Management User's Guide (USATHAMA, 1984).

6.2.5.20. Out-of-Control Situations. Failure to pass the instrumental calibration or control sample QC criteria or analyzing any sample or sample extract beyond the holding times represents an out-of-control situation and calls for corrective action as required by the USATHAMA QA Plan, which may require rerunning and/or resampling and rerunning the entire lot samples. Written notification of QC failure is provided to the ESE Project Manager, the Chemistry Supervisor, and Project QA Staff.

6.2.5.21. An out-of-control situation for accuracy and precision control charts may be indicated by the following:

1. A value falls outside the control limits or is classified as an outlier by the Dixon's test.

2. A series of seven successive values fall on the same side of the central line.

3. A series of five successive values lie in the same direction.

4. A cyclical pattern occurs.

5. Two consecutive points fall between the warning and control limits.

6. Values of greater than or equal to 1/3 of the analytes of a multi-analyte method fall outside the control limits.

7. Values of analytes of a multi-analyte method fall outside the control limits for two consecutive lots.

6.3 PREVENTIVE MAINTENANCE

6.3.0.1. Regularly scheduled preventive maintenance will be performed to keep all field and laboratory equipment in good working condition.

6.3.1. Field Equipment

6.3.1.1. Detailed information regarding maintenance and servicing is available in the operation manual of the specific instrument to be used. Service and maintenance information will be recorded in field log books by field personnel. Instrument problems encountered during the field program will be recorded and, if possible, remedied in the field. Specific preventive maintenance practices will follow manufacturer's recommendations.

6.3.1.2. General preventive maintenance tasks for the field equipment are outlined in Table 6-3, including the type of equipment and regularly scheduled maintenance tasks. Additional details on equipment maintenance procedures are presented in this DCQAP, USEPA guidance (1987), and the operation manual for the specific piece of equipment.

6.3.2. Laboratory Equipment

6.3.2.1. ESE has implemented a preventive maintenance program that meets the requirements of the USATHAMA QA program. Detailed preventive maintenance activities are described in laboratory SOPs and in ESE's Master QA Plan.

6.3.2.2. All equipment to be calibrated will have an assigned record number permanently affixed to the instrument. A label will be affixed to each instrument showing: description, manufacturer, model number, serial number, date of last calibration or maintenance, person performing the calibration/maintenance, and due date for next servicing. Calibration reports and compensation or correction figures will be maintained with the instrument. Thermometers are exempt from the labeling requirement, but not from the calibration requirement. The laboratory will maintain an adequate supply of critical spare parts to minimize instrument down-time.

6.3.2.3. A written stepwise calibration procedure is available for each piece of test and measurement equipment. Any instrument which is not calibrated to within the manufacturer's original specifications must display a red warning tag to alert the analyst that the device carries only a "limited calibration." Equipment unable to meet approved calibration specifications will not be used for sample analysis.

6.3.2.4. Instruments past due for calibration or maintenance will be immediately removed from service, either physically or, if this is impractical, by tagging, sealing, labeling, or other means. The labeling and recording system extends to calibration or maintenance services provided to the laboratory by other organizations. Certifications and reports furnished by them should be filed and made a part of the required record keeping system.

TABLE 6-3

FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Instrument Type	Maintenance Tasks
Specific Conductivity (SC) Meter	• Check charge on battery regularly. Recharge or replace, as appropriate.
pH Meter	• Clean cell cup or electrode with deionized water after each reading. Rinse well. • Check that pH electrode contains sufficient liquid. • Ensure that the outside of the probe stays moist. • Check sensor bulb for development of film if drifting is a problem – lightly clean with liquid cleanser. • Rinse electrode with deionized water and replace storage cap after each use.
Temperature Meter	• Regularly clean and maintain the instrument and any accessories.
Photoionization Detector	• Check charge on battery. Recharge or replace as appropriate. • Check UV lamp and ion chamber for cleanliness. • Clean probe if deposits develop on UV lamp surface or in ion chamber. • Clean air fan and/or pump if sand grains or dirt are present. • Regularly clean and maintain the instrument and accessories.
Water Level Indicator	• Check charge on battery. Recharge or replace, as appropriate. • Rinse probe and tape after use. • Inspect cable and all electrical connections for breaks and/or bare wire.

6.3.2.5. The following is a brief description of maintenance activities that will be performed for atomic absorption spectrophotometers (AAS), inductively coupled argon plasma (ICAP), gas chromatographs (GCs), and gas chromatograph/mass spectrometer (GC/MS).

6.3.2.6. Atomic Absorption Spectrophotometer. Routine preventive maintenance on the AAS consists of keeping components clean (to prevent acid corrosion), replacement of expendable parts, and monitoring instrument response. Instrumental response is compared to historical data and the manufacturers' performance specifications to verify instrument sensitivity. Sample cells (e.g., graphite furnace, hydride cell, and burner/spray chamber) will be cleaned periodically to prevent serious contamination. Sufficient stock of spare parts will be kept to ensure continuous operation. Manufacturers' service representatives will inspect instrument optics and other components at least once per year.

6.3.2.7. Inductively Coupled Argon Plasma. Analyses run on the ICAP system require specific instrument calibration and maintenance controls. Routine maintenance on the ICAP system by the manufacturers' representatives is performed on an annual basis. In addition, a quarterly service contract is maintained on the ICAP system minicomputer. The analyst will dismantle, clean, and reassemble the torch and nebulizer when response falls below method sensitivity requirements. Calibration with selected standards will be performed daily to ensure that the instrument performance has not deteriorated. The failure to achieve standardization could require cleaning, including changing the tubing of the sample delivery system. Spare parts are available for the system components most likely to experience failure.

6.3.2.8. Gas Chromatograph. GC septa will be replaced on a weekly basis or more frequently as needed when symptoms of septum deterioration are noted. Frequent injections will require replacement on a daily basis. When the supply of gas in the cylinders falls below 100 psi, carrier and detector gases will be changed to prevent contaminants from reaching the detector or columns. Molecular sieves and oxygen traps used in the gas lines will be replaced on a regular basis. GC detectors will be removed and cleaned periodically to remove accumulations which can affect instrument performance.

Instrument calibration curves will be monitored and compared to historical performance criteria. Excessive noise, low response, and poor precision are indicators of a dirty detector and may cause more frequent detector cleaning. Spare columns, packing materials, instruments cables, and personal computer boards will be available in case of breakage or malfunction to minimize instrument downtime.

6.3.2.9. Gas Chromatograph/Mass Spectrometer. Daily instrument control will be practiced to ensure that the instrument is calibrated and in proper working condition. The GC/MS will be tuned, as necessary, with perfluorotributylamine to calibrate the mass axis and to ensure proper relative abundances. The GC/MS will be tuned daily with difluorotriphenyphosphine (DFTPP), these outputs are contained in the instrument tuning log, for nonvolatiles analysis and bromofluorobenzene (BFB) for volatiles analysis. An instrument tuning log will be maintained to identify any deterioration of instrument performance. The intensity specifications for DFTPP and BFB are contained in Table 6-4. Failure to achieve calibration will require implementation of source cleaning procedures.

6.3.2.10. In addition, all routine analytical systems controls performed for GC will also be performed for the GC/MS equipment. The ionizing source will be dismantled, thoroughly cleaned, and reassembled when response falls below method sensitivity requirements.

6.4 AUDITS

6.4.0.1. An audit assesses the capability and performance of a measurement system, or its components, and identifies problems warranting correction. Two types of audits may be conducted during the RFI at N TEAD. The first type of audit, a systems audit, is used to verify adherence to QA policies and Standard Operating Procedures (SOPs). This type of audit may consist of on-site reviews of measurement systems, including facilities, equipment, and personnel. Additionally, procedures for measurement, quality control, and documentation may be evaluated. System audits are conducted on a regularly scheduled basis, with the first audit conducted shortly after a system becomes operational.

TABLE 6-4

MASS INTENSITY SPECIFICATIONS FOR DFTPP AND BFB

Key Ions	Ion Abundance Criterion
For DFTPP[a]	
51	30 to 60 percent of mass 198
68	Less than 2 percent of mass 69
70	Less than 2 percent of mass 69
127	40 to 60 percent of mass 198
197	Less than 1 percent of mass 198
198	Base peak, 100 percent relative abundance
199	5 to 9 percent of mass 198
275	10 to 30 percent of mass 198
365	Greater than 1 percent of mass 198
441	Present but less than mass 443
442	Greater than 40 percent of mass 198
443	17 to 23 percent of mass 442
For BFB[a]	
50	15 to 40 percent of mass 95
75	30 to 60 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5 to 9 percent of mass 95
173	Less than 2 percent of mass 174
174	Greater than 50 percent of mass 95
175	5 to 9 percent of mass 174 (1 to 12 percent of mass 174 [b]
176	Greater than 95 percent but less than 101 percent of mass 174
177	5 to 9 percent of mass 176

(a) Reference: Test Methods for evaluating Solid Waste, EPA-SW-846, 3rd Edition, November 1986.

(b) Variance of 1 to 12 percent of mass 174 for ESE, Gainesville, FL, GC/MS Instrument D.

Source: ESE (1990)

The second type of audit, a performance audit, is used to determine the accuracy of a measurement system or its components. Performance audits are conducted regularly in conjunction with laboratory performance evaluations.

6.4.0.2. Performance and system audits will be conducted on both field activities, laboratory analyses, and the overall quality of the project. Specific audit activities are discussed in this section.

6.4.1. Field Activities

6.4.1.1. An audit will be conducted during each phase of field activities to assess and document the performance of technical operations. All auditors will be independent of the activities audited, and will be selected by the project manager. Technical expertise and experience in auditing will be considered in the selection of an auditor or audit team. The field audit check list included in Appendix F will be the basis of audits.

6.4.2. Laboratory Activities

6.4.2.1. Either internal or external audits may be performed to evaluate laboratory activities.

6.4.2.2. External Laboratory Audits. External audits are conducted by representatives of the USATHAMA Chemistry Branch or their representatives. After reviewing the proposed project QA plan, the laboratory may be visited to discuss any weakness in the plan, to evaluate the laboratory's capability to implement the plan, and to discuss any discrepancies in the certification documents, etc. During this visit, the USATHAMA representative will fill out the Audit Checklist as shown in Appendix G. Copies of the completed checklist will be provided to the USATHAMA project officer, the project manager, the analytical task manager, the QC Coordinator, and the USATHAMA Chemistry Branch. If deficiencies are of a serious nature, copies may be forwarded to the contracting officer at Procurement for official documentation and action. The visit may occur before analyses of field samples are initiated by the laboratory.

6.4.2.3. After initiation of the analyses by the laboratory, a USATHAMA representative may visit the field activities or the laboratory to evaluate the effective implementation of the project QA plan. Any project related activities may be evaluated during the visit. Any documents or data required by the USATHAMA QA program are eligible for inspection. Any aspect of the internal audit may be monitored. Findings will be reported to the USATHAMA project officer, the project manager, the analytical task manager, the QC Coordinator, and the USATHAMA Chemistry Branch. If deficiencies are of a serious nature, copies may be forwarded to the contracting officer at Procurement for official documentation and action.

6.4.2.4. Scheduling or completion of the visits noted above does not preclude additional visits, as deemed necessary or desirable.

6.4.2.5. Internal Laboratory Audits. Audits of critical functions by the laboratory QA staff will include:

- Verification that standards, procedures, records, charts, magnetic tapes, etc., are properly maintained;

- Verification that actual practice agrees with written instructions; accomplished through the use of a systems audit where a selected method is monitored through all the steps of its performance. This system audit must be accomplished at least once each quarter, if the laboratory effort are long term; or once a month if the laboratory effort is short term. Methods must be selected so that all phases of a laboratory's effort is monitored, to include but not be limited to sample logging, chain-of-custody, sample preparation, standard preparation, extract storage and analysis and data reduction;

- Verification that QA records are adequately filed and maintained so as to assure protection and retrievability; and

- Assessment of results of QC sample analyses.

6.4.2.6. Auditing will consist of observations and notations as to whether approved practices are followed. A formal audit report comprised of summary findings shall be distributed to the project manager, analytical task leader, and USATHAMA. Deviations will be noted and discussed with the staff member, appropriate management, and with

USATHAMA. The audit and findings, both compliance and non-compliance, must be documented in a bound logbook, or permanently attached and maintained as part of the QA documentation. The QA office will maintain by project, a file(s) of audit reports and findings; copies of reports and findings that cover more than one project shall be maintained in each project file. At the conclusion of a project or task order, copies of the QA file shall be transmitted to the USATHAMA Chemistry Branch, along with the data packages.

6.4.3. Project Reviews

6.4.3.1. Project reviews will be scheduled and conducted by the program manager. The intent of a project review is to assess scope compliance and overall technical quality of the contracted services. The Criteria Committee, consisting of senior technical staff selected by the program manager, apply the accumulated experience of the company to a service during the conduct of the work. A project review is appropriate at instances such as (1) sampling design plan finalization; (2) end of field program; and (3) determination of conclusion and recommendations. Documentation of the project review, especially identified action items and their follow-up, is essential to maximizing the utility of these reviews.

6.5 CORRECTIVE ACTION PROCEDURES

6.5.0.1. An effective QA program requires prompt and thorough correction of nonconformances affecting data quality. Rapid and effective corrective action minimizes the possibility of questionable data or documentation.

6.5.0.2. Two types of corrective actions exist: immediate and long-term. Immediate corrective actions include the correction of documentation deficiencies or errors; the repair of malfunctioning instrumentation; or the correction of inadequate procedures. Often, the source of the problem is obvious and can be corrected quickly. Long-term corrective actions work to eliminate the source of problems. Examples of long-term corrective actions include the correction of systematic errors in sampling or analysis, or the correction of procedures producing questionable results. Corrections can be made through proper personnel training, instrument replacement, and/or procedural improvements.

6.5.0.3. All QC problems and corrective actions will be documented to provide a complete record of QC activities and help identify needed long-term corrective actions. Defined responsibilities are required for scheduling, performing, documenting, and assuring the effectiveness of the corrective action. This section describes the corrective action procedures to be followed in the field and laboratory.

6.5.1. Field Procedures

6.5.1.1. Definition of Field Nonconformances. Field nonconformances are defined as occurrences or measurements that are: (1) either unexpected or do not meet established acceptance criteria and (2) will impact data quality if corrective action is not implemented. Nonconformances may include the following:

- Incorrect use of field equipment
- Improper sample collection, preservation, and shipment procedures
- Incomplete field documentation, including Chain-of-Custody Records
- Incorrect decontamination methods
- Incorrect collection of QC samples.

In general, any unapproved modification to procedures described in this DCQAP may be considered a nonconformance.

6.5.1.2. Field Corrective Action Procedures. Corrective action procedures will depend on the severity of the nonconformance. In cases where immediate and complete corrective action is implemented by field personnel, corrective actions will be recorded in the field log book and summarized in the field progress report.

6.5.1.3. Nonconformances identified during an audit that have a substantial impact on data quality require the completion of a Corrective Action Request Form as shown in Figure 6-1. This form may be filled out by an auditor or any individual who suspects that any aspect of data integrity is being affected by a field nonconformance. Each form is limited to a single nonconformance. If additional problems are identified, multiple forms will be used for documentation.

Project Number: ______________________________

Location: ______________________________

To (Project Manager): ______________________________

From (Reviewer): ______________________________

Date: ______________________________

Description of Problem: ______________________________

Corrective Action Required: ______________________________

The above corrective action must be completed by: ______________

Corrective Action Taken: ______________________________

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N TEAD
CORRECTIVE ACTION REQUEST FORM
FIGURE 6-1

PROJECT MANAGER: ____________________
(Subcontractor QA Manager)

Acknowledgement of Receipt

____
(Date / Initial)

Corrective Action Completed

____
(Date / Initial)

Reviewer:
Corrective Action is / *is not* satisfactory

____
(Date / Initial)

Remarks: ____________________

QAQC Coordinator:
Corrective action is / *is not* satisfactory

____
(Date / Initial)

Remarks: ____________________

cc: Program Manager
Program QA Manager

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CORRECTIVE ACTION REQUEST FORM
FIGURE 6-1

6.5.1.4. Copies of a completed corrective action request form will be distributed to the project manager, the field operations leader, the project QC Coordinator, and the project file. The project QC Coordinator will forward forms to the program manager as appropriate. Key personnel will meet to discuss the following:

- Determine when the problem developed
- Assign responsibility for investigation and documentation of the problem
- Determine the corrective action needed to eliminate the problem
- Design a schedule for completion of the correction action
- Assign responsibility for implementing the corrective action
- Document and verify that the corrective action has eliminated the problem
- Determine whether USATHAMA should be notified.

6.5.1.5. Figure 6-2 presents a Corrective Actions Status Report form to be used by the project QC Coordinator to monitor the status of all corrective actions. In addition to a brief description of the problem and the individual who identified it, the report will list personnel responsible for the determination and implementation of the corrective action. Completion dates for each phase of the corrective action procedure will also be listed, along with the due date for the project QC Coordinator to review and check the effectiveness of the solution. A follow-up date, or "poke date", will also be listed to check that the problem has not reappeared. This follow-up is conducted to ensure that the solution has adequately and permanently corrected the problem.

6.5.2. Laboratory Procedures

6.5.2.1. The internal laboratory corrective action procedures are contained in the laboratory Master QA Manual and SOPs. At a minimum, corrective action will be implemented when control chart warning or control limits are exceeded, method QC requirements are not met, or sample holding times are exceeded. Out-of-control situations will be reported to the analytical task manager. The two categories of corrective actions that may occur within the laboratory are described below:

- Immediate, to correct or repair nonconforming equipment and systems. The need for such an action will most frequently be identified by the analyst as a result of calibration checks and QC sample analyses.

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PROJECT NUMBER: ______ Navy QC Level ______

PROJECT MANAGER: ______ STATUS AS OF (DATE): ______

Corrective Action No.	Brief Description	Originator Initials and Date	Determination and Implementation				Effectiveness	
			Initials	Due Date	Initials	Due Date	Initials	"Poke Date"

Project QC Coordinator Signature / Date: ______

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CORRECTIVE ACTION STATUS REPORT
FIGURE 6-2

- Long term, to eliminate causes of nonconformance. The need for such actions will probably be identified by audits. Examples of this type of action include:

    - Staff training in technical skills or in implementing the QC program

    - Rescheduling of laboratory routine to ensure analyses are performed within allowed holding times

    - Identifying vendors to supply reagents of sufficient purity

    - Revision of laboratory QA program or replacement of personnel.

6.5.2.2. For either immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

- Define the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Assign and accept responsibility for implementing the corrective action
- Establish effectiveness of the corrective action and implement the correction
- Verify that the corrective action has eliminated the problem.

6.5.2.3. Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, corrective action employed, and verification that the problem has been eliminated must be documented.

6.5.2.4. In addition, if the corrective action results in the preparation of a new standard or calibration solution(s), then a comparison of the new versus of the old solution needs to be performed and the results supplied with the weekly USATHAMA QC submittal as verification that the problem has been eliminated.

6.6 QUALITY CONTROL CHECKS AND FREQUENCY

6.6.0.1. Internal quality control checks were developed to ensure that field sampling and laboratory analysis activities generate data of acceptable accuracy and precision. As described below, field checks will be conducted on a regularly scheduled basis. Laboratory checks will be conducted according to USATHAMA protocols. A discussion of measurements and procedures for internal quality control is presented in this section.

6.6.1. Field Quality Control Samples

6.6.1.1. Field QC samples are collected for laboratory analysis to check sampling and analytical accuracy and precision. The QC samples for this project include: duplicate field samples, matrix spike and matrix spike duplicate samples, trip blanks, source water blanks, equipment rinsate samples, background samples, and filter blanks. The rate of collection of these samples is presented on Table 6-5.

6.6.1.2. Field Duplicate Samples. A duplicate field sample is collected at the same time and from the same source as the original sample, but submitted to the laboratory separately to assess small scale variability. Duplicate field samples will be composited prior to submittal to the laboratory, with the exception of samples for volatile organic compounds (VOCs). Field duplicates will be collected and analyzed for 10 percent of the total number of samples. Both soil and groundwater duplicates will be sampled from locations having the greatest potential for contamination. These samples will be collected, numbered, packaged, and sealed in the same manner as other samples.

6.6.1.3. Matrix Spike and Matrix Spike Duplicate Samples. Matrix spike and matrix spike duplicate (MS/MSD) samples will be selected by the laboratory in coordination with the field team leader. MS/MSD pairs will be analyzed at a rate of five percent for the overall project. A MS/MSD sample pair will not necessarily be included with each analytical lot. Sufficient sample volume will be collected for analysis of MS/MSD water samples; MS/MSD soil samples will be obtained from the same container as the field sample.

6.6.1.4. Upon arrival at the laboratory, the MS/MSD samples will be spiked with target analytes and analyzed according to the referenced method. Results from the analysis of

TABLE 6-5

SUMMARY OF FIELD QUALITY CONTROL SAMPLES

QC Sample Type	Soil	Water	Analyses	Comments
Field Duplicate	10%	10%	Same as field sample	Collect in areas of expected contamination
Matrix Spike/Matrix Spike Duplicate Pair	5%	5%	Same as field sample	One pair will not necessarily be included in each analytical lot
Equipment Rinsate	1 per day[c]	1 per day[b]	Same as previous field sample	
Trip Blank	1 per cooler[a]	1 per cooler	VOCs only	
Filter Blank	NA[a]	1 per site per round	Metals only	

NA Not applicable
(a) EPA guidelines do not suggest blank samples for soil samples
(b) Equipment rinsate analyzed every other day.
(c) One per day or one for every 20 samples whichever is more frequent.

MS/MSD samples will be used to evaluate the effect of the matrix on precision and accuracy. The percent recoveries will be calculated for each of the analytes detected and used to assess analytical accuracy. The relative percent difference between samples will be calculated and used to assess analytical and sampling precision.

6.6.1.5. Equipment rinsate (equipment blank) samples are used to evaluate the cleanliness of the soil and groundwater sampling equipment. A minimum of one blank per site for soils and one blank per day for groundwater is scheduled during sampling. An equipment blank is collected by rinsing the decontaminated sampling equipment (i.e., bailers, pump and discharge tubing, or soil sampling tools) with deionized water and collecting the rinse water in the appropriate sample containers. The presence of analytes in the sampling equipment will be accessed by analyzing equipment blank samples for the same parameters as the field samples. A sample of the deionized water used for equipment blanks will be obtained directly from the water container and sent to the laboratory for analysis.

6.6.1.6. Trip Blanks. Trip blanks are samples used to identify possible sample contamination originating from sample transport, shipping, or site conditions. These sealed samples will be prepared in the laboratory using organic-free water. They will then be shipped with the groundwater and soil sample containers to the field, stored with the field samples, and returned to the laboratory with the VOC samples. One trip blank will accompany each cooler containing water VOC samples and will be analyzed for VOCs.

6.6.1.7. Filter Blanks. Groundwater and surface water samples scheduled for metals analysis will be filtered in the field prior to preservation and analysis. To assess the cleaning procedures of the filtration apparatus, the potential for cross-contamination, and the potential contribution to the sample from the filter itself, a filtration blank will be collected and analyzed. The filtration blank will be prepared by passing deionized water through a freshly cleaned filtration apparatus, then preserving the sample for the planned analyses. Filter blanks will be collected at a rate of one per sampling round (five wells) for the groundwater monitoring well sampling program (SWMU-14), and one per sampling activity at the other SWMUs where surface water samples will be collected. Filtration blanks will be preserved and handled in the same manner as other metals samples.

6.6.1.8. Source Water. The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment decontamination must be approved by the Contracting Officer prior to arrival of the drilling equipment on-site. The following factors are looked for by USATHAMA in selection of a water source:

- A deep aquifer origin (ideally, greater than 200 feet below ground surface)

- Well head upgradient of potential contaminant sources

- Water free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified or in the process of being certified by USATHAMA for those contaminants

- Water that is not treated or filtered

- A water source with a tap having 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500-gallon tank in less than 20 minutes

- The use of only one designated tap for access.

6.6.1.9. N-TEAD supply well WW-I satisfies these requirements and has been selected as the source for water during the field program. Analytical data from the source samples will be submitted as required in the USATHAMA Geotechnical Requirements on the Water Approval Request Form as shown in Appendix H. Approval from the Contracting Officer will be obtained prior to the arrival of any drilling equipment on site, as required. Three calendar weeks will be allowed from the time of receipt by USATHAMA for request evaluation and recommendation.

6.6.1.10. Background Samples. The purpose of background samples is to determine the ambient chemical concentrations in samples collected near hazardous waste sites in the matrices of interest. A prerequisite for these samples is that they are not influenced by site contamination. As described in Section 4.3.9., 20 surface and 20 shallow subsurface soil samples representative of the soil types found at each of the SWMUs will be collected from areas removed from site activity. In addition, one deep soil boring will be drilled in a soil representative of the primary soil type found in the OB/OD area to provide background soil data for subsurface soil.

6.6.1.11. The organic chemical analytes at TEAD are not naturally occurring. Because of the remote nature of TEAD, as well as the lack of industrial activity in the TEAD vicinity, ambient concentrations of manmade chemicals in suitable background areas are not expected. Therefore, only naturally occurring analytes, metals and anions, will be analyzed for in the background samples. Soil pH will also be determined because of the effect it has on anion and metal mobility. Data from the background samples will aid in the risk assessment and will be used to interpret the fate of water and soil during the RFI.

6.6.1.12. One background groundwater sample will be collected. This well is the most upgradient of the piezometers and is not near a potentially hazardous waste source.

6.6.2. Laboratory Quality Control Samples

6.6.2.1. Laboratory QC samples will be analyzed at the frequency specified in the *USATHAMA QA Plan* and in the method. The two main types of laboratory QC samples are method blank samples and control samples spiked with target and/or surrogate analytes.

6.6.3. Sample Custody

6.6.3.1. Documentation during sampling activities is essential to ensure proper sample identification. Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. The field operations leader is responsible for proper sample handling and documentation that will allow for tracing possession and handling of individual samples from the time of collection to laboratory receipt. ESE has an established sample control system that allows for tracing sample possession from laboratory receipt to final sample disposition.

6.6.3.2. Chain-of-custody procedures provide an accurate written record tracing the possession of individual samples from the time of field collection through laboratory analysis. A sample is considered in custody if one of the following applies:

- It is in a person's possession
- It is in view after being in physical possession
- It is in a secure area after having been in physical custody
- It is in a designated secure area, restricted to authorized personnel.

6.6.3.3. Field Procedures. The sample custody and documentation procedures employed in the field are discussed below. All sample custody and documentation material will be completed by field personnel in indelible ink. Corrections will be made by drawing one line through the incorrect entry, entering the correct information, and initialling and dating the change. Sample custody materials discussed in the following subsections include sample labels, custody seals, and COC records. Additional documentation related to sample identification and custody include:

- Field log books
- Boring logs
- Groundwater development and sampling logs
- Photographs

Procedures associated with the use of these documents are discussed in this DCQAP.

6.6.3.4. Sample Label. Sample labels as shown in Figure 6-3, will be prepared by the laboratory prior to shipment of sample containers to N TEAD. These labels will include the laboratory project number; project name; sample location; laboratory sample identification number; and spaces for entry of the samples initials, date and time of collection and sample depth. Sample labels will be completed and attached to sample containers at the time of sample collection.

6.6.3.5. Chain-of-Custody Record. Project-specific COC Records will be printed by the laboratory; example forms are presented in Appendix B. COC Records will include the laboratory identification number, sample location, sample fraction (abbreviation for sample container type and preservative), parameter list (abbreviation for the list of analyses to be performed), sample type, site type, and installation ID. In addition, there are spaces for entry of the sample collection date and time, sample depth, sample collection technique, signature of the persons relinquishing and receiving samples, and the status of samples upon receipt by the laboratory. Unused portions of the form will be crossed out.

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LABEL NUMBER

SAMPLE DATE

SAMPLE TIME

PROJECT NAME/LOCATION

PRESERVATIVE

SAMPLE LOCATION

SAMPLER'S INITIALS

FIELD ID NUMBER

GRAB

COMPOSITE

ANALYSIS

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N TEAD
SAMPLE LABEL
FIGURE 6-3

Preprinted COC Records will ensure sample custody is documented, appropriate sample fractions are collected, planned analyses are assigned, and sample information necessary for entry into IRDMIS is provided to the laboratory.

6.6.3.6. A Shipment Record as depicted in Figure 6-4, will be completed in addition to the COC Record to provide a concise summary of the samples included within each ice chest. COC Records, along with the Shipment Record initiated in the field, will be signed, placed in a plastic bag and taped to the inside of the shipping container used for sample transport. Signed airbills will serve as evidence of custody transfer between the field sampler and courier, and the courier and laboratory. Copies of the COC Record, the Shipment Record and the airbill will be retained and filed by the sampler prior to shipment.

6.6.3.7. Custody Seals. Custody seals will be used on each ice chest to ensure tampering detection. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler and are shown in Figure 6-5. At least two custody seals will be placed on each ice chest.

6.6.3.8. Laboratory Procedures. Sample custody procedures are also necessary in the laboratory from the time of sample receipt to the time the sample is discarded. A detailed description of custody procedures is included in ESE's Master QA Plan and in SOPs. The following procedures are recommended by USATHAMA for the laboratory (USATHAMA, 1990):

- A specific person shall be designated custodian and an alternate designated to act as custodian in the custodian's absence. All incoming samples shall be received by the custodian, who shall indicate receipt by signing the accompanying custody forms and who shall retain the signed forms as permanent records.

- The sample custodian shall maintain a permanent log book to record, for each sample, the person delivering the sample, the person receiving the sample, the date and time received, the source of the sample, the sample identification or log number, how the sample was transmitted to the laboratory, and the condition received (sealed, unsealed, broken container, or other pertinent remarks). A standardized format should be established for log book entries. A sample

TOOELE ARMY DEPOT

SUMMARY OF SAMPLE SHIPMENT TO ESE

SITE I.D.	DEPTH (FEET)	SAMPLE TYPE (H2O/SOIL)	ESE SAMPLE NO.	TYPE AND NO. OF CONTAINERS	DATE SHIPPED

COOLER NO.: ______________________ AIR BILL NO.: ______________________

DATE SHIPPED: ______________________ COMPLETED BY: ______________________

Attach field logsheet / COC and include in each cooler.

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SAMPLE SHIPMENT RECORD
FIGURE 6-4

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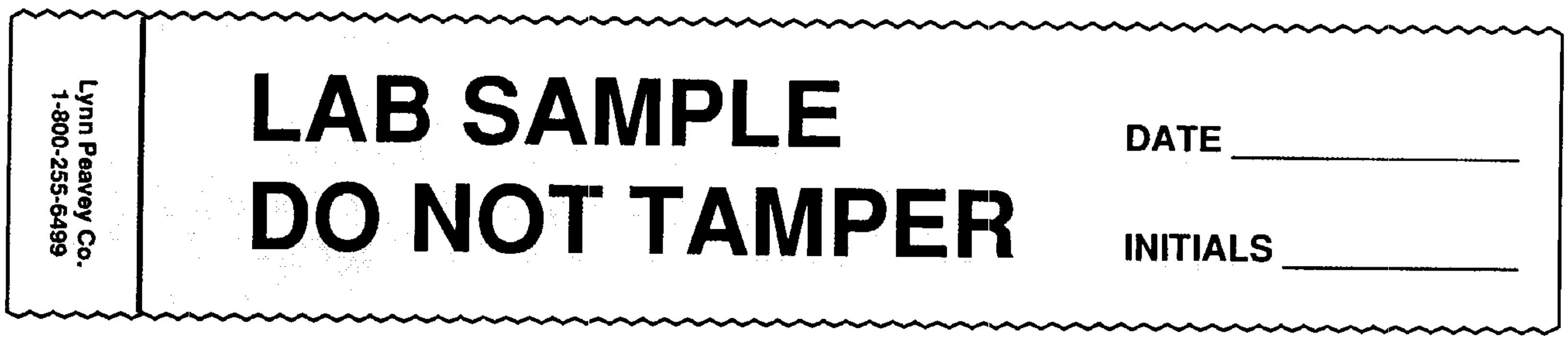

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N TEAD
CUSTODY SEAL
FIGURE 6-5

receipt checklist shall be used by the sample custodian as an aid in logging in the samples. A copy of the checklist shall be incorporated into the lot data package.

- A clean, dry, isolated room, building, and/or refrigerated space that can be securely locked from the outside shall be designated as a "Sample Storage Security Area". The custodian shall ensure that heat-sensitive, light-sensitive, radioactive, or other samples having unusual physical characteristics or requiring special handling, are properly stored and maintained prior to analysis.

- Each sample or sample fraction removed from the sample storage area will be recorded on a check-in/check-out form posted outside the storage room door. The sample number, date of removal, and the person's initials will be clearly recorded. Upon return, the sample number, date of return, and the person's initials will be recorded on the form. Analysts will return samples and sample fractions to the return shelf only. The coldroom custodian will be responsible for returning the samples to the proper shelf location.

- Laboratory personnel are responsible for the care and custody of the sample once it is received by them and shall be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the coldroom until the time that the analyses were completed.

- Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the coldroom. The returned tagged sample should be retained in the custody room until permission to destroy the sample is received.

- Samples shall be destroyed only after all analytical results have been validated to Level 3 in the USATHAMA data management system and such action is approved by the USATHAMA project officer. Samples may be required to be held in storage longer to fulfill contractual requirements or as directed by the USATHAMA project officer.

6.7 CALIBRATION PROCEDURES AND FREQUENCY

6.7.0.1. Standard calibration procedures exist for all field equipment to be used for on-site monitoring and testing. Laboratory equipment used for sample analysis also have prescribed calibration procedures. These procedures along with the required frequency of calibration are discussed below.

6.7.1. Field Measurement Equipment

6.7.1.1. Numerous instruments and meters will be used in the field during the investigation. Measurement equipment expected to be used during the field activities include a specific electrical conductance (EC) meter, pH meter, temperature meter, water level indicator, and PID meter.

6.7.1.2. Each piece of field measurement equipment requiring calibration will be calibrated prior to each day's use. In addition, a calibration check will be performed at the conclusion of each day of use in order to evaluate instrument drift. Instruments will not be adjusted before the calibration check has been performed and recorded. Calibration activities will be documented in a log book or an appropriate logsheet. The procedures described in the following subsections apply to the specific instrument noted. If other instruments are used, the manufacturers' calibration procedures will be followed.

6.7.1.3. Specific Conductance Meter. The SC meter will be calibrated prior to use each day with a commercially prepared potassium chloride standard solution that has a concentration similar to the expected field values. Distilled water will be used to establish the zero-point setting for each calibration. The calibration of the instrument will be checked anytime meter draft is suspected.

6.7.1.4. pH Meter. The pH meter will be calibrated prior to use each day that the unit is used. The calibration will include the setting of the range and span with a 7.0 pH buffer and a 4.0 pH or 10.0 pH buffer, depending on whether acidic or alkaline water conditions are expected. The calibration of the instrument will be checked at the end of each day of use and anytime meter drift is suspected. Standards will be commercially prepared.

6.7.1.5. Temperature Meter. Groundwater temperature will be measured using the temperature compensation probe on the pH meter, the SC meter, or with a mercury thermometer.

6.7.1.6. Water Level Indicator. The water level indicator will be calibrated before commencement of field activities by checking the markings on the tape against a measurement tape. Readings will be recorded to the nearest 0.01 foot.

6.7.1.7. PID Calibration. The HNU photoionization detector will be calibrated according to the following procedure:

- With the probe attached to the instrument, turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged prior to any calibration. If the red LED signal comes "on", the battery should be recharged. Next, turn the function switch to the on position. In this position, the ultraviolet (UV) light source should be on.

- To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection, while counterclockwise rotation yields a downscale deflection. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero. The instrument is now ready for calibration by switching the function switch to the proper measurement range.

6.7.1.8. Using nontoxic analyzed gas mixture (isobutylene) available from the manufacturer in pressurized containers, connect the cylinder with the analyzed gas mixture to the end of the probe with a piece of tubing. Open the valve of the pressurized container such that a known flow of gas is obtained and the instrument's response can be evaluated. Now adjust the span potentiometer so that the instrument is reading the stated value of the calibration gas.

6.7.1.9. If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted if necessary. If the instrument does not calibrate, it may be necessary to clean the probe or the lamp connection.

6.7.1.10. FID Calibration. The primary calibration for the Foxboro OVA-128 flame ionization detector is performed at the factory to 100 ppm methane gas. Secondary calibration will be performed according to manufacturer's specifications at the beginning of each sampling activity. Those specifications are described in the following paragraph.

6.7.1.11. Calibration of the OVA may be accomplished using a single known sample of methane in air in the range of 90 to 100 parts per million (ppm), as described below:

1. Place instrument in normal operation with CALIBRATE switch set to x 10 and GAS SELECT control set to 300.

2. Use the CALIBRATE ADJUST (zero) knob to adjust the meter reading to zero.

3. Introduce a methane sample of known concentration (between 90 and 100 ppm, not to exceed 1,000 ppm) and adjust trimpot R-32 so the meter reading corresponds to the known sample.

4. This sets the instrument gain for methane with the panel mounted gain adjustment (GAS SELECT) set at a reference number of 300.

5. Turn off HYDROGEN SUPPLY VALVE to put out flame.

6. Leave CALIBRATE switch on x 10 position and use CALIBRATE ADJUST (zero) knob to adjust meter reading to four ppm.

7. Place CALIBRATE switch in x 1 position and using trimpot R-31, adjust meter reading to 4 ppm.

8. Move CALIBRATE switch to x 10 position again. Use CALIBRATE ADJUST (zero) knob to adjust meter to a reading of 40 ppm.

9. Move CALIBRATE switch to x 100 position and use trimpot R-33 to adjust meter reading to 40 ppm.

10. Move CALIBRATE ADJUST (zero) knob to adjust meter reading to zero.

11. Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

6.7.2. Laboratory Instruments

6.7.2.1. Daily QC of the analytical system ensures that accurate and reproducible results are produced. The analyst must check instrumental calibration data for compliance with QC requirements. Table 6-6 describes the general instrumental QC checks to be implemented, unless specified differently in the approved USATHAMA methods.

6.7.2.2. Initial calibration should be performed under the following conditions: (1) analysis is first setup or prior to the first set of samples, (2) the instrument has been idle for a long period of time, (3) the instrument detector has been subject to major maintenance, (4) the instrument fails the daily calibration QC checks, or (5) the instrument is used to analyze analytes different from those for which the instrument was calibrated previously.

6.7.2.3. When available, standard analytical reference material (SARM) supplied by USATHAMA will be used to prepare calibration standards and spiking standards. SARMs or interim SARMs are materials that have undergone extensive purity and stability checks. If SARMs are not available or their quantities limited, "as is" chemicals may be used as interim reference materials. However, the "as is" material is stored at 0°C and a portion retained for comparison with the approved SARMs when available.Any "as is" chemical must be characterized for compound identity and purity and results provided to USATHAMA with the certification performance data package. Organic standards will be characterized for purity using capillary gas chromatography/flame ionization detection (GC/FID) analysis and for identify using GC/MS analysis. Inorganics standards will be

TABLE 6-6

SUMMARY OF INSTRUMENTAL SYSTEMS
CONTROL REQUIREMENTS

Requirement	Analytical Control Limits
Initial Calibration–Minimum Testing Range	
Class 1	• Calibration curve–concentration series OX (Blank), 0.5X, 1X, 2X, 5X, and *10X, where X is the target reporting limit
	• *10X daily calibration standard at end of the day
	• Check standard, *10X, at beginning and end of day
Class 1A	• Calibration curve–concentration series OX (blank), 0.5X, 2X, and *10X
	• *10X daily calibration standard at end of the day
Class 1B	• Calibration curve–concentration series OX (blank), 0.5X, 2X, and *10X
	• *10X daily calibration standard at end of the day
	• Check standard, *10X, at beginning of the day
Daily Calibration–Minimum Testing Range	
Classes 1, 1A, 1B	• *10X daily calibration standard analyzed at beginning and end of day

*10X = 10 percent to 25 percent range extension, which allows for fluctuations from a theoretical 100-percent method recovery.

Source: ESE, 1990

Class 1: Non-GC/MS standard sample throughout methods.
Class 1A: GC/MS methods.
Class 1B: Non-GC/MS low sample throughout methods.

identified against known National Institute of Standards and Technology (NIST) or USEPA standards.

6.7.2.4. All reference compounds used in the USATHAMA projects will be stored at 0°C and protected from light. The laboratory QA staff will request SARMs as required, monitor their use and maintain a record of receipt of SARMs.

6.7.2.5. Documentation of Standard Preparation. Standard preparation notebooks are kept to document preparation of independent stock and working solutions for: (1) calibration stock solutions, intermediates, and working solutions; (2) calibration reference working solutions (if reference is a concentrate or reference had to be prepared in the lab); and (3) control spike stock solutions, intermediates, and working solutions. Copies of the appropriate pages from these notebooks are provided in each analytical lot folder.

6.7.2.6. Calibration Checks. Calibration standards are verified with independent reference solutions when available, otherwise independent stocks solutions are prepared. The analysis of the reference standard is required with each initial calibration. If an initial calibration is run daily, then the reference sample is required on a weekly basis. Reference standards are not required when a daily calibration protocol is followed since the daily calibration standards must be verified to the initial calibration curve. Other calibration quality control involves analysis of continuing calibration check standard (or drift check). Acceptance criteria are documented in each method.

6.8 ASSESSMENT OF DATA QUALITY

6.8.0.1. All QC data generated through the analysis of a sample set will be reviewed and evaluated as part of the data validation. Statistical assessment of data quality will supplement data validation activities described in Section 5.4. Laboratory results for each parameter analyzed will be evaluated on the basis of precision, accuracy, representativeness, comparability, and completeness criteria. The assessment procedures for each of these criteria are described in Section 6.1.

REFERENCES

AEHA, 1982. Final Report, Hazardous Waste Management Special Study No. 80-26-0207-83, Tooele Army Depot, Tooele, Utah, March 15 - September 26, 1982, Aberdeen Proving Ground, Maryland.

AEHA, 1983. "Phase 2 - Hazardous Waste Special Study No. 39-26-0147-83, DARCOM Open Burning/Open Detonation Grounds Evaluation, Tooele Army Depot, Utah," U.S. Army Aberdeen Proving Ground, Maryland.

AEHA, 1984. "Phase 3 - Hazardous Waste Special Study No. 39-26-0147-83, DARCOM Open Burning/Open Detonation Grounds Evaluation, November 1981 - September 1983;" U.S. Army, Aberdeen Proving Ground, Maryland.

AEHA, 1985. "Phase 4 - Hazardous Waste Study No. 37-26-0462-85, AMC Open Burning/Open Detonation Grounds Evaluation. Investigation of Soil Contamination at the Open Burning Ground, Tooele Army Depot, Utah, 27 July - 10 August 1984," U.S. Army, Aberdeen Proving Ground, Maryland.

AEHA, 1987. "RCRA Part B Permit Writers Guidance Manual for Department of Defense Open Burning/Open Detonation Units," Aberdeen Proving Ground, MD.

AEHA, 1989. "Hazardous Waste Management Consultation No. 37-26-0277-89, Residue from Burning PCP-Treated Wood, Tooele Army Depot, Utah," Aberdeen Proving Ground, Maryland; January 1989.

Allen, 1989. Personal interview conducted by G. Mikesa, Senior Environmental Engineer, E. C. Jordan Co. with F. Allen, N TEAD employee; November 2, 1989.

ASTM, 1990. American Society for Testing and Materials (ASTM), 1990. Annual Book of ASTM Standards; June 1990.

Bishop, 1990. Telephone interviews conducted by J. MacKinnon, Environmental Engineer and P. Ianni, Senior Scientist, E.C. Jordan Co. with J. Bishop, N TEAD employee, July 18, 1990 and July 31, 1990.

Brems and Kensinger, 1989. Personal interview conducted by T. Kipp, Senior Scientist, E.C. Jordan Co. with L. Brems and J. Kensinger, N TEAD employees, November 2, 1989.

Clark, 1990a. Telephone interview conducted by P. Ianni, Senior Scientist, E.C. Jordan Co. with R. Clark, employee, Tooele Army Depot, North Area; April 19, 1990.

Clark, 1990b. Telephone interview conducted by L. Espy, Hydrogeologist, E.C. Jordan Co. with R. Clark, employee, Tooele Army Depot, North Area; July 31, 1990.

Curry, D.R. and Others, 1984. Major Levels of the Great Salt Lake and Lake Bonneville, Utah. Utah Geological and Mineral Survey, Map 73, 1:750,000 scale.

E.C. Jordan Co. (Jordan), 1989. Site Visit Walkover and Interviews - Tooele Army Depot, North Area; requested by U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, October 31 - November 2, 1989.

E.C. Jordan Co., 1990a. "Final Resources Management Plan - Tooele Army Depot, North Area;" Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; January 1990.

E.C. Jordan Co., 1990b. "Final Quality Assurance Project Plan - Tooele Army Depot, North Area;" Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; December 1990.

E.C. Jordan Co., 1990c. "Final Health and Safety Plan - Tooele Army Depot, North Area;" Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; December 1990.

E.C. Jordan Co., 1990d. "Final Site Investigation Work Plan - Tooele Army Depot, North Area;" Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; December 1990.;

EA Engineering, Science, and Technology, Inc. (EA), 1988. "Tooele Army Depot Preliminary Assessment/Site Investigation Final Draft Report, Volume I - North Area," prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; February 1988.

EPIC, 1982. "Environmental Photographic Interpretation Center (EPIC) Report prepared for USATHAMA, under Interagency Agreement No. RW-2930148-01-8, 1982.

ERTEC, 1982. "Assessment of Environmental Contamination Exploratory Stage, Tooele Army Depot, Tooele, Utah;" Volumes I-IV, October, 1982.

ESE, 1991. "Groundwater Quality Assessment for Tooele Army Depot, Tooele, Utah. Prepared for U.S. Army Corps of Engineers by ESE , Inc.; February, 1991.

Everitt and Kaliser, 1980. "Geology for Assessment of Seismic Risk in the Tooele and Rush Valleys, Tooele County, Utah;" Utah Geological and Mineral Survey, Special Studies No. 51.

Fisher, 1990. Telephone interview conducted by E.C. Jordan, Inc. with L. Fisher, EMO, N TEAD; 1990.

Fisher, 1991. Telephone interview conducted by David Shank, Hydrogeologist, James M. Montgomery Consulting Engineers, Inc. with L. Fisher, EMO N TEAD employee; November 1991.

Fox, 1989. Personal interview conducted by D. Shank, Hydrogeologist, James M. Montgomery Consulting Engineers, Inc. with W. Fox, N TEAD employee; December 6, 1989.

Gates, J.S., 1965. "Reevaluation of the Ground-Water Resources of Tooele Valley, Utah;" Utah State Engineer, Technical Publication No. 12.

Heard, 1991. Personal communication by Deborah Drain, James M. Montgomery Consulting Engineers, Inc.; with Robert Heart, Chem Nuclear, November, 1991.

JMM, 1987. "Alternate Concentration Limit Position Paper, Tooele Army Depot, Utah;" prepared for U.S. Army Corps of Engineers, Huntsville, Alabama; Project No. 1587.0510; March, 1987.

JMM, 1988. "Final Groundwater Quality Assessment Engineering Report to the Tooele Army Depot, Utah;" prepared for U.S. Army Corps of Engineers, Huntsville, Alabama; Project No. 15870621; December 1988.

JMM, 1989. James M. Montgomery Consulting Engineers, Inc. site visit and interview with Dick Clark (EMO) by David Shank and others, December 1989.

JMM, 1990. N TEAD site(s) walkover by D. Shank, Hydrogeologist, James M. Montgomery Consulting Engineers, Inc.; January 31, 1990.

JMM, 1991. James M. Montgomery, Inc. site visit by David Shank and others, October 29, 1991.

Mander, 1989. Inventory of Drummed Wastes at 90-Day Drum Storage Area, conducted by G. Mander, N TEAD employee; 1989.

Mascarenas, 1990. Telephone interview conducted by E.C. Jordan, Inc. with former N TEAD employee, Henry Mascarenas, 1990.

McCoy, Mel, 1989. Personal Communication between Tim Kipp of E.C. Jordan Co., and Mel McCoy of Tooele Army Depot, Tooele, Utah, November 1989.

Nichols, 1991. Telephone interview conducted by David Shank with Engineering and Logistics Directorate Buildings and Grounds Section employee, Bill Nichols, December, 1991.

NUS, 1987. "Draft Interim RCRA Facility Assessment," prepared for U.S. Environmental Protection Agency; USEPA Contract No. 68-01-7310; July 1987.

Rasmussen, 1991. Laboratory data transmitted from Roger V. Rasmussen, TEAD Environmental Engineer, to Daniel Shrum, Associate Hydrogeologist, James M. Montgomery, Inc. on November 19, 1991.

Ray, 1990. Telephone interview conducted by J. MacKinnon, Environmental Engineer, E.C. Jordan Co. with K. Ray, N TEAD employee; July 26, 1990.

Razem, A.C., and J.I. Steiger, 1981. "Ground-Water Conditions in Tooele Valley, Utah, 1976-1978;" State of Utah Department of Natural Resources, Technical Publication No. 69.

Roy F. Weston, Inc. (WESTON), 1990a. "Final Draft Remedial Investigation Report, Tooele Army Depot - North Area Remedial Investigation," prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; Contract No. DAAA15-85-D-0015; May 1990.

Roy F. Weston, Inc. (WESTON), 1990b. "Final Draft Remedial Investigation Report, Tooele Army Depot - North Area Remedial Investigation," prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; prepared by Clement Associates, Inc., Fairfax, Virginia; Contract No. DAAA15-85-D-0015; May 1990.

Roy F. Weston, Inc. (WESTON), 1990c. "Final Draft Remedial Investigation Report, Tooele Army Depot - North Area Remedial Investigation, Volume 3;" prepared for U. S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, Contract Number DAAA15-85-0-0015; May 1990.

Rutishauser, 1990. Letter from Paul W. Rutishauser, Director, TEAD Directorate of Ammunition Operations to Daniel Shrum, Associate Hydrogeologist, James M. Montgomery, Inc., dated November 19, 1991.

Siniscalchi, 1991. Telephone interview conducted by David Shank, Hydrogeologist, James M. Montgomery Consulting Engineers, Inc. with Jeff Siniscalchi, N TEAD employee; November 19, 1991.

Smith, 1990. Telephone interview conducted by P. Ianni, Senior Scientist, E.C. Jordan Co. with D. Smith N TEAD employee; January 9, 1990.

Snyder, 1990. Telephone interview conducted by P. Ianni, Senior Scientist, E.C. Jordan Co. with R. Snyder, N TEAD employee; July 31, 1990.

Tooele, 1991. Telephone communication by Deborah Drain, James M. Montgomery Consulting Engineers, Inc. with Tooele County Commissioner's Office receptionist, December 1991.

Tooker, E.W. and R. J. Roberts, 1970. Upper Paleozoic Rocks in the Oquirrh Mountains and Brigham Mining District, Utah, U.S. Geological Survey Professional Paper 629-A.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1987a. "USATHAMA Quality Assurance Program, 2nd Edition;" Aberdeen Proving Ground, Maryland; March 1987.

U.S. Environmental Protection Agency (USEPA), 1989. RCRA Facility Investigation (RFI) Guidance Vol. I-IV OSWER Directive 9502.00-60, May, 1989.

U.S. Environmental Protection Agency (USEPA) Environmental Monitoring Systems Laboratory, 1982. "Installation Assessment, Tooele Army Depot (North Area), Utah," prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland; No. AR-21-F-1-202-0; January 1982.

USATHAMA, 1987b. "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports;" Aberdeen Proving Ground, Maryland; March, 1987.

USATHAMA, 1987c. "General Contract Statement for USATHAMA UXO Contractor Support;" USATHAMA Safety Office CETHA-SF.

USATHAMA, 1989. Users Guide to Installation Restoration Data Management Information System (IRDMIS) prepared by Potomac Research, Inc. (PRI), November, 1989.

USATHAMA, 1990a. Heppner, Mary Ellen, USATHAMA Contracting Officers Representative. Interview by Gretchen Mikeska, Senior Environmental Engineers, E. C. Jordan Co.; Portland, Maine; February 1, 1990.

USATHAMA, 1990b. "USATHAMA Quality Assurance Program, 3rd Edition;" Aberdeen Proving Ground, Maryland; January 1990.

USEPA, 1987. "Expanded Site Inspection (ESI) Transitional Guidance for FY 1988;" OSWER Directive 9345.1-02; Office of Emergency and Remedial Response; October 1987.

USSCS, 1991. Personal interview with Tooele County Soil Conservation Service, conducted by Deborah Drain, James M. Montgomery Consulting Engineers, Inc., November 1991.

Woodward-Clyde Consultants (WCC), 1986. "Final Draft Groundwater Quality Assessment Tooele Army Depot, Volume I;" prepared for Department of the Army Huntsville Division, Corps of Engineers; Contract No. DACA87-84-C-0071; April 1986.

Woodworth, 1989. Laboratory results of E.P. Toxicity tests for metals on Activated Carbon, forwarded to E.C. Jordan Co. from Dave Woodworth, N TEAD EMO, 1989.

Zaugg, 1991. Telephone interview conducted by David Shank (JMM) with Mark Zaugg, N TEAD (AED) Director. December, 1991.

APPENDIX A

USATHAMA GEOTECHNICAL REQUIREMENTS

GEOTECHNICAL REQUIREMENTS

FOR

DRILLING, MONITOR WELLS, DATA ACQUISITION, AND REPORTS

March 1987

Department of the Army
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD 21010-5401

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I. OBJECTIVE.

The objective of these requirements is to set forth the geotechnical criteria and procedures of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These requirements are used in technical support of the Contracting Officer for geotechnical exploration and reporting. The application of geotechnology to environmental programs should begin with project conception. The Geotechnical Requirements join this application during the design of the field program, after the initial magnitude of the study has been determined and tentative well sites selected. The application of these requirements is intended to provide acceptable technical data and tracking procedures to accurately obtain, describe, and evaluate representative samples of the subsurface environment in terms of geology, hydrology, and groundwater chemistry. This sample-specific data can be merged with site-operational knowledge to characterize and appraise the contaminant potential of the site.

II. GENERAL POLICY.

A. The Geotechnical Requirements shall be a part of and attached to each Request for Proposal or Quotation (RFP/RFQ) involving subsurface exploration and resulting contracts and/or task orders. A verbatim copy of these Requirements, modified by only the initial contract or task order and subsequent amendments, shall be made part of and attached to the contractor's Technical Plan (or equivalent document).

B. The Geotechnical Requirements were written as a generalized document. Application to a specific contract or task is likely to generate obvious or subtle conflicts. When conflicts exist between the Geotechnical Requirements and specific contractual documents; i.e., the RFP/RFQ, contract, task order, or contractual amendments, the latest contractual documents shall take precedence.

C. Technically, the Contracting Officer is the only Governmental agent who has the authority to change a given contract. Some administrative aspects of this authority are usually delegated in writing to certain USATHAMA personnel serving as Contracting Officer's Representatives (COR). These aspects include the approval for use of specified items; e.g., the drilling water, granular filter pack, bentonite, etc., as discussed in the Geotechnical Requirements. USATHAMA's approval of these items is performed through and under the authority of the Contracting Officer. Therefore, the contractor's requests for approval of, variance from, or notification of problems with the technical items within these Geotechnical Requirements shall be directly sent from the contractor to the USATHAMA COR responsible for that contract or task.

D. Any deviation from the contract shall be requested of and approved by the Contracting Officer. Deviations approved for a given contract or task shall not be applicable to any other contract or task unless specified in the approval.

E. These requirements will be updated as required incorporating new technology, experience, and policy.

III. SPECIFIC ELEMENTS.

A. Drilling Operations.

1. Drilling Methods.

a. The object of drilling method selection is to use that technique which:

(1) Minimizes subsurface contamination or cross contamination.

(2) Provides representative data.

(3) Minimizes drilling costs.

b. To this end, the following drilling methods are typically used:

(1) Hollow-stem augers.

(2) Water/mud rotary.

(3) Cable tool/churn drill.

(4) Air rotary.

c. Of these, air rotary is the least desirable and is further discussed in section III.A.2. Other methods, like reverse circulation, may have applicability in certain cases. Unless specified in the RFP/RFQ, the drilling method shall be suggested and described by the contractor in his RFP/RFQ response and/or technical plan, for the Contracting Officer's consideration and approval.

2. Air Rotary.

a. Air systems, including bottled gas, shall not be used for drilling, well installation, well development, presample purging, or sampling unless specified in the statement of work. However, when alternative bids or proposals are allowed, the contractor may present as part of the bid/proposal package an alternative using an air system(s) for a given operation(s). The contractor's alternative shall include:

(1) Situation.

(2) Recommendation.

(3) The effect of usage upon groundwater and soil chemical analyses.

(4) Alternatives with cost savings or increases, as appropriate.

b. The above item shall be quantified, costed (in the appropriate section of the bid/proposal package), and shall incorporate the appropriate criteria discussed in paragraph III.A.2.c. below. Consideration and a recommendation by USATHAMA will be made during the course of bid/proposal evaluation, prior to contract award.

c. In general, air system plans shall:

(1) Specify the type of air compressor and lubricating oil and require a pint sample of each oil be retained by the contractor, along with a record of oil loss (on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon contract/task completion.

(2) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes shall be made if oil is visibly detected in the filtered air.

(3) Prohibit the use of any additive except approved water (III.A.10.b.) for dust control and cuttings removal.

(4) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

d. Air usage shall be fully described in the log or associated geotechnical report to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluations of the system performance, both design and actual.

3. Recirculation Tanks and Sumps. Portable recirculation tanks are suggested for mud/water rotary operations and similar requirements. The use of dug sumps/pits (lined or unlined) is expressly prohibited.

4. Site Geologist. A geologist shall be present and responsible at each operating drill rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of that rig. Each geologist shall be responsible for only one operating rig. Each geologist shall have onsite sufficient tools and professional equipment in operable condition to efficiently perform his/her duties as outlined in these <u>Geotechnical Requirements</u> and other contractual documents. Items in the possession of each geologist shall include, as a minimum: a copy of the geotechnical portion of the statement of work, the USATHAMA-approved Technical Plan (or equivalent) which incorporates these <u>Geotechnical Requirements</u>, the approved Safety Plan (approved after contract award), a 10X (minimum) hand lens, and a weighted (with steel or iron) tape(s), long enough to measure the deepest well within the contract, heavy enough to reach that depth, and small enough to readily fit within the annulus between the well and drill casing. Each geologist shall also have onsite a water level measuring device, preferably electrical.

5. Permits, Rights-of-Entry, and Licenses. The contractor shall be responsible for securing and complying with any and all boring or well drilling permits and/or procedures required by state or local authorities and

for determining and complying with any and all state or local regulations with regard to the submission of well logs, samples, etc. Submission of these items to state or local authorities shall be coordinated through USATHAMA. The contractor shall telephonically notify USATHAMA immediately in the event of any apparent discrepancy between contractual and state or local requirements. Notification shall include the nature of the discrepancy; the name, agency, and telephone number of the person noting the discrepancy; and the current status. Any rights-of-entry (for off-post drilling) will be obtained for and supplied to the contractor by the Contracting Officer. The contractor shall ensure that all drilling of boreholes, well installation, and topographic surveying is accomplished by companies appropriately licensed in the project State. A copy of each current license (denoting expiration date) shall be provided in the contractor's Technical Plan. If the project State does not require a licensed driller for this project, then a statement to that effect shall be included in the technical plan.

6. Drilling Safety and Underground Utility Detection. The contractor shall be responsible for determining and complying with any and all (to include host installation) regulations, requirements, and permits with regard to drilling safety and underground utility detection. The contractor shall include a discussion of his actions with regard to these items in his proposal and Safety Plan (also see III.A.12.b., III.A.12.d., and III.G.).

7. Lubricants. Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenyls (PCBs).

8. Surface Runoff. Surface runoff; e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, shall not enter any boring or well either during or after drilling/well construction. To help preclude this, the use of starter casing, recirculation tanks, berms about the borehole, and surficial bentonite packs, as appropriate, are suggested.

9. Antifreeze. If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The contractor shall note on the boring log the dates, reasons, quantities, and brand names of antifreeze per above.

10. Materials.

a. Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. Exception is usually made for some high yield bentonites to which the manufacturer has added a small quantity of polymer. The use of any bentonite must be approved by the Contracting Officer prior to the arrival onsite of the drilling equipment (rigs). This includes bentonites (powders, pellets, etc.) intended for drilling mud, grout, seals, etc. The following data, III.A.10.a.(1)-(5), shall be submitted in writing (see Figure 1) through USATHAMA to the Contracting Officer as part of the approval request. Allow six working days from the time of receipt by USATHAMA for request evaluation and recommendation.

(1) Brand names(s).

(2) Manufacturer(s).

(3) Manufacturer's address(es) and telephone number(s).

(4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

b. Water.

(1) The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the Contracting Officer prior to arrival of the drilling equipment onsite. Parameters for approval include:

(a) A deep aquifer origin (ideally, greater than 200 feet below ground surface).

(b) Well head upgradient of potential contaminant sources.

(c) Free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified by or in the process of being certified by USATHAMA for those contaminants. Pretesting shall be conducted on duplicate samples, each analyzed at a different time, using separate lots.

(d) The water to be non-treated and non-filtered.

(e) The tap to have 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500 gallon tank in less than 20 minutes.

(f) The use of only one designated tap for access.

(2) Periodic testing of the approved water source may be required when the water is used to clean the sampling equipment after well installation. A detailed discussion of these requirements is provided in the USATHAMA Quality Assurance Program.

(3) Surface water bodies shall not be used, if at all possible.

(4) If a suitable source exists onsite, the contractor shall be directed to that source. If no onsite water is available, the contractor shall locate a potential source and submit the following data, III.A.10.b.(4)(a)-(h), in writing to USATHAMA (see Figure 2) for the Contracting Officer's approval prior to the arrival of any drilling equipment onsite. Allow three calendar weeks from the time of receipt by USATHAMA for request evaluation and recommendation.

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of treatment and filtration prior to tap (chlorination, fluoridation, softening, etc.).

(e) Time of access (24-hours per day, 5-days per week, etc.).

(f) Cost per gallon charged by Owner/Operator.

(g) Results and dates of all available chemical analyses over past two years. Include the name(s) and address(s) of the analytical laboratory(s)

(h) Results and date(s) of duplicate chemical analysis (see III.A.10.b.(1)(c)) for project contaminants by a laboratory certified by or in the process of being certified by USATHAMA for those contaminants.

(5) The contractor has the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The contractor is also responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

(6) The contractor shall enter the chemical and geotechnical data for the approved water source into the Data Management System.

c. Grout.

(1) Materials. Grout, when used in monitor well construction or well abandonment, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

(2) Equipment. All grout materials shall be combined in an above-ground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremie. The grout pump for recirculation and placement shall be a commercially available product specifically manufactured to pump cement grouts. The tremie pipe shall be of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies. Hoses and flexible PVC are unacceptable. Grout placement, via gravity and the grout head, using an elevated grout tank is expressly prohibited.

(3) Grout shall be placed in the monitor wells as follows:

(a) When a bentonite seal is used as shown in Figures 5 or 6:

(i) Prior to exposing any portion of the borehole above the seal by the removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and drill casing shall be filled with grout.

(ii) The grout shall be placed from within a rigid tremie pipe, located just over the top of the seal.

(iii) The grout shall be pumped through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The grout shall not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(iv) The drill casing shall then be removed and more grout immediately added to compensate for settlement.

(v) If drill casing (to include hollow-stem auger) was not used, proceed with grouting to ground surface in one, continuous operation.

(vi) After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression.

(vii) Repeat this process until firm grout remains at ground surface.

(viii) Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USATHAMA on the well diagram (or addendum).

(b) When no bentonite seal is used (unusual occurrence requiring specific Contracting Officer approval):

(i) The contractor shall mix, place, monitor, and report grout usage as described above: III.A.10.c.(1) to (3)(a)(viii), but position the rigid tremie pipe just above the granular filter pack.

(ii) Place the grout so as to avoid grout penetration into the underlying granular filter pack and screen.

(4) If field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing.

(5) For grout placement at depths less than ten feet in a DRY hole, the grout may be poured in place from ground surface.

d. Granular Filter Pack. For this discussion, refer to section III.C.5.

e. Well Screens, Casings, and Fittings. For a discussion of these materials, see section III.C.2.

f. Well Caps and Centralizers. These items are discussed in sections III.C.3. and 4, respectively.

g. Well Protection. Elements of well protection are covered in section III.C.8.

h. Tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically required by contract.

i. Summarize the usage of these and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. Include this summary within the geotechnical report. An example summary is provided at Table 1.

11. Abandonment. Abandonment is that procedure by which any boring or well is permanently closed. Abandonment procedures shall preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment.

a. The abandonment of any borings or wells not scheduled for abandonment per contract, must be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Abandonment requests shall be submitted telephonically through USATHAMA to the Contracting Officer with the following data, III.A.11.a.(1)-(3), plus recommendation. Allow four consecutive hours from the time of receipt by USATHAMA for request evaluation and decision. Frequently, resolution is made within minutes. Infrequent circumstances may preclude a four-hour resolution. A written followup memorandum shall be submitted by the contractor within five working days of the telephonic request. This document shall be forwarded through USATHAMA to the Contracting Officer and contain the following data:

(1) Designation of well/bore in question.

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.).

(3) Reason for abandonment.

(4) Action taken, to include any replacement boring or well.

b. Each boring or well to be abandoned shall be sealed by grouting from the bottom of the boring/well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole shall be grouted in the same manner also. Grout composition, equipment, and placement procedures are covered in section III.A.10.c.

c. After 24 hours, the contractor shall check the abandoned site for grout settlement. That day, any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

d. Normally an abandoned well shall be grouted with the well screen and casing in place. However, a lack of data concerning well construction or other factors may dictate the removal of the well materials and a partial or total hole redrilling prior to sealing the well site.

e. For each abandoned boring/well, a record shall be prepared to include the following, III.A.11.e.(1)-(13), as applicable. Report all depths/heights from ground surface. The original record shall be submitted to USATHAMA within three working days after abandonment is completed.

(1) Boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 20 feet north and 20 feet west of Well 14.

(3) Open depth prior to grouting and depth to which grout pipe placed. This includes the depth of open hole, open depth to the bottom of the well, and the open depth in the well-borehole annulus.

(4) Casing left in hole by depth, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Drilled and sampled depth prior to decision to abandon site.

(8) Items left in hole by depth, description, and composition.

(9) Description and total quantity of grout used initially.

(10) Description and daily quantities of grout used to compensate for settlement.

(11) Dates of grouting.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: height above ground, size, and composition.

f. Ideally, replacement wells/borings (if any) will be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

12. Soil Samples.

a. Unless otherwise specified in the contract, intact soil samples for physical descriptions, retention, and potential physical analyses shall be taken and retained every five feet or at each major change of material, whichever occurs first. The contractor may propose an alternate sampling frequency in his technical plan. These samples shall be representative of their host environment and are to be obtained with driven (e.g., split spoon), pushed (e.g., thin wall), or rotary (e.g., Denison) type samplers. Auger flight or wash samples will not satisfy this requirement.

b. At the detection of any unusual odors off the auger turnings or intact samples, drilling shall cease for an evaluation of their nature and crew safety. After the field crew completes this evaluation and implements any appropriate safety precautions, drilling shall resume. If the odors are judged by the field crew to be contaminant-related, intact samples shall be continuously taken until the odors are no longer detected in the samples. At that time, normal sampling shall resume. Specific procedures shall be detailed in the contractor's proposal and Safety Plan.

c. Representative soil samples from each sampler shall be placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars). These jars shall be stored in individual compartments in cardboard boxes. A single box shall not contain more than 24 one-pint jars or 48 half-pint jars. For thin wall (shelby) samples, retain a sample from each tube as described above. The remaining portion may be wasted or sealed in the tube, as per testing requirements. Minimum information on each sample container shall include the boring and sample number. No geotechnical data shall appear on the container that is not specified on the boring log. Jars and tubes shall be kept from freezing.

d. Physical soil testing shall be conducted on ten (10) to twenty (20) percent of the soil samples using procedures and equipment described in the current U.S. Army Corps of Engineers Manual, EM 1110-2-1906: Laboratory Soils Testing, or current Annual Book of ASTM Standards, American Society of Testing and Materials, Part 19. Tested samples shall be representative of the range and frequency of soil types encountered. In addition, they shall be obtained from borings that cover the geographic and geologic range within the study area of the host Army installation. The contractor shall select the particular samples. Tests shall include Atterberg Limits, sieve grain size distribution, and assignment of Unified Soil Classification System symbols. Laboratory and summary sheets shall be submitted to the COR within ten working days of final test completion. The contractor shall address any contaminant-related safety precautions for the physical analysis of these samples in his proposal and Safety Plan.

e. Soil samples for chemical analysis taken from borings shall be obtained in a manner to provide intact specimens; using a split spoon or solid barrel sampler, Denison sampler, etc. These samples shall be extracted from their host environment in as near an intact, undisturbed condition as technically practical. Once at the surface, the sampler shall be opened, sample extracted, peeled, and bottled in as short a time as possible. "Peeling" is a process whereby that portion of the sample which was in direct contact with the sampler, as well as the ends of the sample, are removed and discarded. Samples for volatile analysis shall be peeled, bottled, and capped within fifteen (15) seconds from the time of opening the sampler. Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in the current Quality Assurance Program.

f. All soil samples, except those for physical and/or chemical analysis and reference shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

13. Rock Core. The preferred method of drilling bedrock is through coring. This method, using a diamond or carbide studded bit, produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few feet), the enlargement of a previously cored hole, or the drilling of highly fractured intervals.

a. The coring of bedrock or any firm stratigraphic unit shall be conducted in a manner to obtain at least 90% intact recovery. The physical character of the bedrock; i.e., fractures, poor cementation, weathering, or solution cavities, may lessen the desired recovery, even with the best of drillers and equipment.

b. While drilling in bedrock, and especially while coring, drilling fluid pressures shall be adjusted to minimize drilling fluid losses and hydraulic fracturing.

c. Rock cores shall be stored in covered wooden boxes in such a manner as to preserve their relative position by depth. Intervals of lost core shall be noted in the core sequence with annotated wooden blocks. Boxes shall be marked inside and out to provide boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box shall not exceed 75 pounds. No geotechnical data shall appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for each boring shall be on hand prior to coring that site.

d. The core within each completed box shall be photographed after the core surface has been cleaned/peeled and wetted. Photos shall be taken using color film (ASA as appropriate), 35mm camera, 55mm (minimum) lens, light meter, with one box per frame. Each photo shall be in sharp focus and contain both a legible scale in feet and tenths of feet (or centimeters) and a USATHAMA-supplied photographic color chart for color comparison. The core shall be oriented so that the top of the core is at the top of the photo. One set of 3 x 5 inch glossy color prints plus all negatives shall be sent to USATHAMA via registered mail within 2 weeks of the last coring. Each photo shall be annotated on the back as to the bore/well designation, box number, and cored depths denoted in the photograph. The photos shall be used to enhance the interpretation of core sketches and corresponding narrative descriptions.

e. All rock core, except that for analysis and reference, shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

14. Drilling in Contaminated Areas. Many borings and wells are drilled in areas that are clean relative to the deeper horizons of interest. However, circumstances do arise which require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation requires the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleaned of all previous drill fluids prior to proceeding into the deeper, "cleaner" environment. These situations shall be addressed by the contractor on a case-by-case basis in the technical plan.

15. Equipment Cleaning. The steam cleaning of all drilling equipment to include rigs, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., shall be done prior to project site (installation) arrival followed by onsite steam cleaning with approved water (III.A.10.b.) upon site arrival and between boring/well sites. Prior to use onsite, all casings, augers, recirculation and water tanks, etc., shall be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, need not be removed from drilling equipment. To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross- or downgradient from any site to be sampled.

16. Work Area Restoration, Disposal of Borehole Cuttings and Well Water. All work areas around the wells and/or borings installed as part of this contract shall be restored to a physical condition equivalent to that of preinstallation. This includes cuttings removal or spreading and rut removal. Borehole cuttings, drilling fluids, and water removed from a well during installation, development, aquifer testing, and presample purging shall be disposed of in a manner approved by the Contracting Officer and the host installation. The contractor shall suggest a disposal procedure and location(s) as part of his technical plan.

17. Physical Security.

a. On Post: While physical security measures are present on most Army properties, the contractor has the ultimate responsibility for securing his own equipment. The contractor shall address any special needs to the onsite installation personnel and include these items in his technical plan.

b. Off Post: For any operations off post, the contractor is totally responsible for his own physical security.

B. Borehole Logging. Each boring log shall fully describe the subsurface environment and the procedures used to gain that description.

1. Format. The format of the boring log shall be determined by the contractor. A suggested format is presented in Figure 4.

2. Submittal. Each original boring log shall be submitted directly from the field to the Contracting Officer's designated office within three working days after the boring is completed. In those cases where a monitor well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram must be submitted within three working days after the instrument is installed.

3. Originals. Only the original boring log (and diagram) shall be submitted from the field to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice.

4. Time of Recording. Logs shall be recorded directly in the field without transcribing from a field book or other document. This technique reduces offsite work hours for the geologist, lessens the chance for errors of manual copying, and allows the completed document to be field-reviewed closer to the time of drilling.

5. Routine Entries. In addition to the data desired by the contractor and uniquely required by contract, the following information shall be routinely entered on the boring log or attached to the log:

a. Depths/heights shall be recorded in feet and fractions thereof (tenths or inches). Metric measurements are acceptable if typically used by the geologist. The DMS does not accept entries in inches.

b. Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69).

c. Soil classifications shall be prepared in the field at the time of sampling by the geologist and are subject to change based upon laboratory tests and/or subsequent review. The mere difference between laboratory and field classification is not sufficient to change the field classification. Additional factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report(s). The contractor shall also initiate any subsequent corrections to the Data Management System.

d. Each soil sample taken (see III.A.12.) shall be fully described on the log. The descriptions of intact samples shall include the following parameters:

PARAMETER	EXAMPLE
Classification	Sandy Clay
Unified Soil Classification Symbol	CL
Secondary Components and Estimated Percentages	Sand: 25% (Fine sand 5%, Coarse sand 20%)
Color (using Munsell Soil or Geological	Gray: 7.5 YR 5.0 (Munsell)

Society of America (GSA) Rock Color Chart), give both narrative and numerical description and note which chart used.	
Plasticity	Low Plasticity
Consistency (cohesive soil)	Stiff
Density (non-cohesive soil)	Loose
Moisture Content. Use relative term. Do not express as a percentage unless a value has been measured.	Dry, moist, wet, etc.
Texture/Fabric/Bedding and Orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain Angularity	Rounded
Depositional Environment and Formation, if named	Glacial till, Twin Cities Formation

e. In the field, visual numeric estimates shall be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning is to be defined on each log or within a general legend.

f. When used to supplement other sampling techniques, disturbed samples; e.g., wash samples, cuttings, and auger flight samples, shall be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" shall be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth.

g. Rock core shall be visually described for the following parameters:

PARAMETER	EXAMPLE
Classification	Limestone, Sandstone, Granite
Lithologic Characteristics	Shaly, Calcareous, Siliceous, Micaceous
Bedding/Banding Characteristics	Laminated, Thin bedded, Massive, Cross bedded, Foliated
Color (using Munsell Soil or GSA Rock Color Chart), give both narrative and numerical description and note which chart was used.	Mod. brown: 5 YR 3/4 GSA

Hardness	Soft, Very hard
Degree of Cementation	Poorly cemented, Well cemented
Texture	Dense, Fine-, Medium-, Coarse-grained, Glassy, Porphyritic, Crystalline
Structure and Orientation	Horizontal bedding, Dipping beds at 30°, Highly fractured, Open vertical joints, Healed 30° faults/fractures, Slickensides at 45°, Fissile
Degree of Weathering	Unweathered, Badly weathered
Solution or Void Conditions	Solid, Cavernous, Vuggy with partial infilling by clay
Primary and Secondary Permeability, include estimates and rationale	Low primary: Well cemented High secondary: Several open joints
Lost Core, interval and reason for loss	50-51', noncemented sandstone likely

h. For rock core, provide a scaled graphic sketch of the core on or with the log denoting by depth the location, orientation, and nature (natural or coring-induced) of all core breaks. Note also the intervals by depth of all lost core and hydrologically significant details. This sketch shall be prepared at the time of core logging, concurrent with drilling.

i. Record the brand name and amount of any bentonite used for each boring along with the reason for and start (by depth) of this use.

j. The drilling equipment used shall be generally described either on each log or in a general legend. Record such information as rod size, bit type, pump type, rig manufacturer and model.

k. Each log shall record the drilling sequence; e.g.:

(1) Opened hole with 8" auger to 9'.

(2) Set 8" casing to 10'.

(3) Cleaned out and advanced hole with 8" roller bit to 15' (clean water, no water loss).

(4) Drove standard sampler to 16.5'.

(5) Advanced with 8" roller bit to 30', 15 gallon water loss.

(6) Drove standard sampler to 31.5'.

(7) Hole heaved to 20'.

(8) Mixed 25 pounds of ABC bentonite in 100 gallons of water for hole stabilization and advanced with 8" roller bit to 45', etc.

l. Record all special problems and their resolution on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates for the start and completion of borings shall be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.

o. The depth of first encountered free water shall be indicated along with the method of determination; e.g., "37.6' from direct measurement after drilling to 40.0';" or "40.1' from direct measurement in 60' hole when boring left overnight, hole dry at end of previous shift;" or "25.0' based on saturated soil sample while sampling 24-26'." Allow the first encountered water to partially stabilize (5 to 10 minutes) and record this secondary level and time between measurements before proceeding. Also describe any other distinct water level(s) found below the first.

p. The estimated interval by depth for each sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, record the length of sampled interval and length of sample recovery. Record the sampler type and size (diameter and length).

q. Record the blow counts, hammer weight, and length of hammer fall for driven samplers. For thin wall samplers, indicate whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken.

r. When drilling fluid is used, quantitatively record fluid losses and/or gains and the interval over which they occur. Adjust fluid losses for spillage and intentional wasting (e.g., recirculation tank cleaning) to more accurately estimate the amount of fluid lost to the subsurface environment.

s. Record the pumping pressures typically used during all rotary drilling operations.

t. Note the total depth of drilling or sampling, whichever is deeper, on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Special abbreviations used on a log and/or well diagram shall be defined either in the log/diagram where used, or in a general legend. The general legend, if used, shall be forwarded to USATHAMA with the first log/diagram submittal. An addendum, if required, shall be sent to USATHAMA with the last log/diagram.

C. Well Installation. In the Geotechnical Requirements, the term "monitor well" is used in a generic sense to include observation wells and piezometers. Observation wells differ from piezometers in the length of the open or screened section of the well and location of the well seal (usually bentonite) in relation to the potentiometric or phreatic surface of the aquifer being measured (see Figure 10). Each monitor well is intended for use as a mechanism through which to obtain a representative sample of groundwater and measure the potentiometric surface seen by that well. The installation of either well type is covered by these Requirements. These Requirements are also applicable to other types of hydrogeologic instrumentation; e.g., lysimeters and well points (see Figure 10). The criteria for these and other special instrumentation will be discussed in the specific RFP/RFQ, contract, task, and/or amendment. Any questions regarding these items should be addressed to the COR.

1. Beginning Well Installation.

a. The installation of each monitor well shall begin within 12 consecutive hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation shall begin within 48 consecutive hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process shall be made until the well has been grouted and drill casing removed. Anticipated exceptions shall be requested in writing by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow three working days from the time of receipt by USATHAMA for request evaluation and recommendation. Data to include in this request are:

(1) Well(s) in question.

(2) Circumstances.

(3) Recommendation and alternatives.

b. In cases of unscheduled delays such as personal injury, equipment breakdowns, sudden inclement weather; or scheduled delays such as borehole geophysics, no advance approval of delayed well installation is needed. In those cases, resume installation as soon as practical. In cases where a partially cased hole into bedrock is to be partially developed prior to well insertion (III.D.11.), the well installation shall begin within 12 consecutive hours after this initial development.

c. Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday.

d. The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling.

2. Screens, Casings, and Fittings.

a. Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All materials shall be as chemically inert with respect to the site environment as technically possible and practical.

b. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. No fitting shall restrict the inside diameter of the joined casing and/or screen. All screens, casings, and fittings shall be new.

c. All well screens and well casings shall be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal shall be removed (via SANDING). Solvents shall NOT be used for marking removal. Washed screens and casings shall be stored in plastic sheeting or kept on racks prior to insertion.

d. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

e. All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5' of the open portion of the screen (see Figures 5 and 6). No solvents or glues shall be permitted for attachment.

f. Silt traps (also called "cellars") shall not be used. A silt trap is a blank length of casing attached to and below the screen. Their use fosters a stagnant environment which could influence analytical results for trace concentrations.

g. Joints within and between the casing and screen shall be compatibly threaded. Thermally welded joints or couplings shall not be used. This prohibition includes threaded or slip joint couplings thermally welded to casing by the manufacturer or in the field. Solvent welded joints may be used only to make casing repairs or to adjust casing height. Any glue or solvent usage shall be described on the log or well diagram. During these repairs or adjustments which require solvent/glue usage, a clean rag should be tightly fit into the intact well casing to catch any glue spillage. This rag shall be attached to a strong twine for ease of rag removal and to preclude rag loss down the well. The rag and twine shall be removed upon repair completion.

h. Gaskets shall not be used on monitor wells.

i. The top of each well installed under these Requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02'.

3. Caps and Vents. The tops of all well casings shall be telescopically capped with loosely fitting PVC, PTFE, or stainless steel covers. These covers shall be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost and secure enough to preclude debris and insects from entering the well. No vents shall be placed in these caps (or well risers/stickup). Therefore, the caps shall be loose enough to allow pressure equalization between the well and atmosphere.

4. Centralizers. Well centralizers, when used, shall be of PVC, PTFE, or stainless steel and attached to the casing via stainless steel fasteners or strapping. Centralizers shall not be attached to the well screen or to that part of the well casing exposed to the granular filter or bentonite seal.

5. Granular Filter Pack.

a. All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USATHAMA. Each sample shall be described, in writing (see Figure 3), in terms of:

(1) Lithology.

(2) Grain size distribution.

(3) Brand name, if any.

(4) Source, both manufacturing company and location of pit or quarry of origin.

(5) Processing method; e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.

(6) Slot size of intended screen.

b. Granular filter packs shall be chemically and texturally clean (as seen through a 10X hand lens), inert, siliceous, and of appropriate size for the well screen and host environment.

c. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work.

d. The final depth to the top of the granular filter shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed filter.

6. Bentonite Seals.

a. Bentonite seals shall be composed of commercially available pellets. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

b. Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.

c. In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout. Figure 6 denotes the seal location.

d. The final depth to the top of the bentonite seal shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed bentonite.

7. Grouting. Grout mix design and placement are detailed in paragraph III.A.10.c.

8. Well Protection.

a. Protective casing shall be installed around each monitor well the same day as initial grout placement around that well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request in writing shall be made prior to drilling. Include in the request the well(s) involved, reason for request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USATHAMA.

b. All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

c. Minimum elements of protection design include:

(1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see Figures 5, 6 and 7).

(2) An 8" protector pipe for 5" wells.

(3) A 6" protector pipe for 4" wells.

(4) A 5" protector pipe for 3" wells.

(5) A 4" protector pipe for 2" wells.

(6) A hinged cover or loose fitting telescoping cap to keep direct precipitation and cover runoff out of the casing.

(7) All protective casing covers/caps secured to the casing by means of a padlock from the date of protective casing installation.

(8) All padlocks at a given site (Army installation) opened by the same key. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USATHAMA upon the conclusion of well placement.

(9) No more than .2' from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment.

(10) The outside only of the protective casing, hinges (if present), and covers/caps painted orange with a paint brush (not aerosol can). Painting required to be completed and dry prior to initially sampling that well. Any color deviations will be conveyed to the contractor by the COR.

(11) The painting of the well designation on the outside of the protective casing, using white paint and a brush. The identification shall be done after the casing is painted as described above. Painting required to be completed and dry prior to initially sampling that well.

(12) The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation (see Figure 7). The pickets shall be painted orange, using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.

(13) The above pickets (III.C.8.c.(12)) shall be supplemented with three-strand barbed wire in livestock grazing areas. Installation required prior to sampling.

(14) The placement of an internal mortar collar within the well-protective casing annulus from ground surface to 1/2 foot above ground surface with a 1/4" diameter hole (drainage port) in the protective casing centered 1/8" above this level (see Figures 5 and 6). The mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement required at least 48 consecutive hours prior to well development.

(15) The application of an approximately .5' thick coarse gravel (3/4" to 3" particle size) blanket extending 4' radially from the protective casing (see Figure 8 for layout and dimensions). Application required prior to development.

(16) Unique specifications for flood protection, if applicable, will be covered on a case-by-case basis.

9. Drilling Fluid Removal. When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the borehole fluid should be removed or displaced with approved water (section III.A.10.b.). This removal is intended to remove or dilute the thick fluid and thus allow the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation shall be initially recorded on the well diagram or boring log and later on the well development record (also see III.D.6., 11., and 14.). Any fluid removal prior to well placement is contingent upon the driller's and the geologist's evaluation of hole stability long enough for the desired well and seal placement.

10. Drilling Fluid Losses in Bedrock. For an option to remove drilling water from bedrock prior to well insertion, see paragraph III.D.11.

11. Schematic Well Construction. Figures 5 and 6 depict schematic well construction. Specific contract requirements described in the statement of work may alter some of the components and/or values shown.

12. Well Construction Diagrams.

a. Each installed well shall be depicted in a well diagram. This diagram shall be attached to the bore log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers.

(9) Height of riser without cap/plug above ground surface (stickup).

(10) Protective casing detail.

(a) Height of protective casing without cap/cover (above ground surface).

(b) Base of protective casing.

(c) Drainage port location and size.

(d) Internal mortar collar location.

(e) Gravel blanket height and extent.

(f) Picket configuration.

b. Describe on the diagram or on an attachment thereto:

(1) The actual quantity and composition of the grout, seals, and granular filter pack used for each well.

(2) The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(4) The joint design and composition.

(5) Centralizer design and composition.

(6) Protective casing composition and nominal inside diameter.

(7) The use of solvents, glues, and cleaners to include manufacturer and type (specification).

(8) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.

(9) Dates for the start and completion of well installation.

c. Each diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three working days after well installation. Do not delay this submission until all elements of well protection have been installed. Submit a supplemental diagram for well protection elements to the same designated office within three working days after all elements of well protection are installed.

d. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. For abbreviations in the diagrams, see section III.B.5.v.

D. Well Development and Presample Purging.

1. Development: Definition and Purpose. As used herein, "well development" is that process by which one restores the aquifer's hydraulic conductivity and removes well drilling fluids, solids, and other mobile particulates from within and adjacent the newly installed well. "Development" can also refer to that process whereby one removes sediment or other built-up materials from a "clogged," older well. The resulting inflow should be as physically and chemically representative of the host aquifer as the following procedures allow for a newly installed well.

2. Timing and Record Submittal. The development of monitor wells shall be initiated not sooner than 48 consecutive hours after nor longer than 7 calendar days beyond internal mortar collar placement. The record of well development (see section III.D.14.) shall be submitted to the COR within three working days after development.

3. Pump and Bailer Usage. Development shall be accomplished with a pump and may be supplemented with a bottom discharge/filling bailer (for sediment removal) and surge block. A bottom discharge/filling bailer may be used in lieu of a pump in 2-inch wells. Bailers shall not be left inside the wells after development is completed.

4. Development Criteria. Development shall proceed in the manner described herein and continue until all the following are met:

a. The well water is clear to the unaided eye.

b. The sediment thickness remaining within the well is less than 1% of the screen length.

c. The conditions of paragraph III.D.5. (below) are met.

5. Volumetric Removal. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), the following apply:

a. For those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes plus five times any water used in granular filter pack placement need be minimally removed. Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Officer's designated office for guidance.

b. For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water,annular water, and that used in filter pack placement as above. The same procedures apply here as above with respect to slow recharge, discoloration, and sediment thickness.

c. See sections III.C.9., III.D.6., and III.D.11. for optional procedures and the requirements if these options are used.

6. Water Additions and Wells with Thick Fluids. Water shall not be added to a well as part of development once the initial seal is placed. However, when a bore, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the contractor should purge or dilute this fluid with clean water from the approved source (also see III.C.9.). A record of purging fluid losses shall be made on both the log or diagram and well development record (III.D.14.). Five times the volume of this loss shall be added to the other volumetric removal requirements for well development.

7. Agents and Additives. No dispersing agents, acids, disinfectants, or other additives shall be used during development or at any other time introduced to the well.

8. Development-Sampling Break. Well development shall be completed at least fourteen consecutive days before well sampling.

9. Pump/Bailer Movement. During development, water shall be removed throughout the entire water column by periodically lowering and raising the pump intake (or bailer stopping point).

10. Development Water Sample. For each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator (or USATHAMA-specified individual) for disposition, within three working days of developing that well. No preservation of these samples is required. However, the contractor shall ensure that these samples do not freeze while in his possession.

11. Partial Bedrock Development. If large drilling water losses occur in bedrock and if the hole is cased to bedrock, the contractor may remove at least five times this volumetric loss prior to well insertion. The intent here is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing thereby reducing the development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed as above. However, the requirement shall still remain to remove at the time of well development at least five times the combination of standing water, water in the saturated annulus, plus that which was added during filter pack placement. Record the amount removed per above on the well diagram and in the well development record (III.D.14.).

12. Well Washing. Part of well development shall be the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation shall be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the riser, well cap, and blank casing between the top of the well casing and the water table. This washing shall be conducted before and/or during development, not after development.

13. Problems. If problems are encountered during development, contact the COR within 24 consecutive hours for guidance.

14. Well Development Record Requirements. The following data shall be recorded as part of development and submitted per section III.D.2.:

a. Well designation.

b. Date(s) of well installation.

c. Date(s) of well development.

d. Static water level from top of well casing before and 24 consecutive hours after development.

e. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion (III.D.11.).

(3) Lost during thick fluid displacement (III.C.9. and III.D.6.).

(4) Added during granular filter placement.

f. Quantity of fluid in well prior to development.

(1) Standing in well.

(2) Contained in saturated annulus (assume 30% porosity).

g. Field measurement of pH before, twice during, and after development using an electrometric device (EPA 150.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020).

h. Field measurement of specific conductance (electrical conductivity) before, twice during, and after development using a conductivity meter (EPA 120.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4 - 79-020). Obtain conductance and pH readings concurrently.

i. Depth from top of well casing to bottom of well (from diagram).

j. Screen length (from diagram).

k. Depth from top of well casing to top of sediment inside well, before and after development.

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface.

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

15. Presample Purging: Definition and Purpose. "Presample purging" refers to the removal of water from a well IMMEDIATELY prior to sample acquisition. This ensures a fresh and representative sample for analysis. In general, the USATHAMA Installation Restoration Program, Quality Assurance Program requires five times the calculated volume of water in the well and saturated well annulus to be removed immediately prior to sampling. Therefore, any water removed from a well as part of "development" shall not be counted toward the volumetric removal required in presample purging. Additional presample purging requirements are discussed in the current USATHAMA Quality Assurance Program.

E. Water Levels.

1. Measurement and Datum. The depth to groundwater shall be measured from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing shall be surveyed for vertical control (see III.I.2). The depths to groundwater shall be converted to elevations for report usage. To enter the depths into the Data Management System, the well riser height above ground surface (stickup) must be subtracted from the above measured depth.

2. Contour Requirements. For contouring and reporting purposes, at least one complete set of static water level measurements shall be made over a single, consecutive 10-hour period for all wells (newly installed and specified) in the project. Static levels in borings not converted to wells shall be included if practical and technically appropriate.

3. Ground and Surface Water. Determine and report the elevations, to within ± 0.1 foot, of any streams, lakes, or open water bodies (natural and man-made), within 300 feet of monitor wells used in this contract or task. Use these data for the refinement of the groundwater contours in the vicinity of surface water if a hydrological connection is believed to exist.

F. Well and Boring Acceptance Criteria.

1. Well Criteria. Wells must be acceptable to the Contracting Officer. Well acceptance shall be on a case-by-case basis. The following criteria shall be used along with individual circumstances in the evaluation process.

a. The well and material placement shall meet the construction and placement specifications of these Geotechnical Requirements as modified, if at all, by the contract/task.

b. Wells/boreholes shall not contain portions of drill casing or augers unless they are contractually required as permanent casing.

c. All well casing and screen materials shall be free of any unsecured couplings, ruptures or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) surrounding each installed well shall form a continuous and uniform structure, free of any fractures or cracks.

e. Any casing or screen deformation or bending shall be minimal to the point of allowing the insertion and retrieval of the pump and/or bailer optimally designed for that size casing (e.g., a 4-inch pump in a 4-inch schedule 40, PVC casing is optimal; a 2-inch pump in a 4-inch casing is not optimal).

f. All joints shall be constructed to provide a straight, nonconstricting, and water-tight fit.

g. Installed wells (fully or partially cased) shall be free of extraneous objects or materials (e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc.).

h. For those monitor wells where the screen depth was determined by the contractor, the well shall have sufficient free water at the time of water level measurement (III.E.2.) to obtain a representative groundwater level for that site. These same wells shall have sufficient free water, at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analysis.

i. Data for all required geotechnical files in the Data Management System shall be acceptably entered and verified by the contractor.

2. Abandoned Borings and Wells. Borings not completed as wells shall be abandoned per section III.A.11. and the data therefrom acceptably entered and verified by the contractor into the Data Management System.

3. Well and Boring Rejection. Wells and borings not meeting these criteria are subject to rejection by the Contracting Officer.

G. Geophysics. The use of geophysical techniques, if required, will be specified in the RFP/RFQ. In the absence of this specification, the contractor should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of his efforts. Special applications may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock, buried drum detection, borehole and well logging, etc. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), resolution, and accuracy. The contractor shall also address the safety aspects of geophysical applications in his proposal and Safety Plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials. If geophysical techniques are used, the same topics shall be addressed in the geotechnical report.

H. Vadose Zone Monitoring. Data acquisition from the vadose (unsaturated) zone shall be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed by the contractor. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), and analytical variances from the current USATHAMA Quality Assurance Program.

I. Topographic Survey.

1. Horizontal Control. Each boring and/or well installed under this contract shall be topographically surveyed by a licensed surveyor to determine its map coordinates using a Universal Transverse Mercator (UTM) or State Planar grid to within ± 3' (± 1 meter).

2. Vertical Control. Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed by a licensed surveyor to within ± 0.05' (± 1.5 centimeters) using the National Geodetic Vertical Datum of 1929.

3. Field Data. The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than five weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, shall be included within the geotechnical or final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control (bench marks, caps, plates, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, and physical location.

J. Data Management System.

1. Usage of the Data Management System (DMS) is a means to record and monitor contract performance; store, compare, and evaluate data; and provide cost-efficient, report quality tables and graphics. The System is thereby useful to both administrative and technical users.

2. The geotechnical data acceptably entered in the computer shall be regarded as having the technically best quality for evaluation and decision making. Any deviation from the field data shall be specified and discussed by the contractor in the geotechnical report (see III.B.5.c. and III.K.3.j.(6)).

3. To computerize all of the field-generated data would be neither useful nor cost-effective for most projects. Therefore, only those items specified in III.J.6. shall be acceptably entered on a routine basis by the contractor for each contract or task. These data shall be entered for new borings, wells, and other sampling points; e.g., existing wells, surface water, sediment, and soils, specified in the contract or task. If the contractor wishes to use additional geotechnical files or entries, the contractor shall first receive COR's approval.

4. The items selected for DMS entry shall be entered in one or more of four geotechnical files:

a. Map File (GMA).

b. Field Drilling File (GFD).

c. Well Construction File (GWC).

d. Groundwater Stabilized File (GGS).

5. These files, and others, along with data entry procedures are fully described in Sections 3 and 4 of the Installation Restoration Data Management User's Guide. Additional geotechnical files are available but are not routinely used. The contract or task will specify additional files to be completed, if required.

6. The following lists, arranged by file, denote those items which the contractor shall acceptably enter and verify. Consult the DMS User's Guide for specific coding.

a. Map File (GMA).

(1) Installation.

(2) Site Type.

(3) Site Identification/Site Number.

(4) Coordinates and Coordinate System.

(5) Ground Surface Elevation.

(6) Source and Accuracy of Mapping Data.

(7) Aquifer.

(8) Pointer Information (cross reference for each boring and associated well(s)).

(9) Source of Data (company and individual).

b. Field Drilling File (GFD).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to First Encountered Water.

(5) Depth to Bedrock.

(6) Depth to Deepest Part of Boring.

(7) Unified Soil Classification System Symbol (expanded for bedrock lithologies).

(8) Lithologic Intervals (by depth and thickness).

(9) Source of Data (company and individual).

(10) Dates.

c. Well Construction File (GWC). The abbreviations in parentheses which follow are the "Action Measurements," as explained in the User's Guide.

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Stickup (STKUP).

(5) Bentonite Seal Interval (BSEAL).

(6) Blank Well Casing Interval (CASE).

(7) Well Casing Diameter (CASED).

(8) Length of Overburden Casing (CSEAL).

(9) Overburden Casing Diameter (CASES).

(10) Total Depth of Boring (DPTOT).

(11) Filter Pack Interval (GFILT).

(12) Grout Interval (GROUT).

(13) Screen Interval (SCREN).

(14) Dates.

(15) Source of Data (company and individual).

d. Groundwater Stabilized File (GGS).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to Water (from ground surface).

(5) Date(s) Measured.

(6) Source of Data (company and individual).

7. Figures 11 to 15 are provided as examples of completed DMS coding sheets for each of the above files using the example boring log and well diagram (Figures 4 and 6, respectively). Additional data required for coding but not shown on Figures 4 or 6 follow:

a. Abbreviations:

GP = General AAP
PALEO = Code used for aquifer at General AAP.

b. Field Data:

(1) Surveyed coordinates for boring in UTM system are:

X : 54321 centimeters
and Y : 99876 centimeters.

(2) Surveyed ground surface elevation for boring is 4321 centimeters, using National Geodetic Vertical Datum of 1929.

(3) Well 87-14 is located in the same hole made by boring 87-14.

(4) Cement grout proportioned per these Requirements (cement:bentonite = 20:1).

(5) Well screen: 4" PVC, Schedule 40, .01 inch slot.

(6) Well installed 8 Nov 87.

(7) Water levels recorded by Mr. Smith after development were as follows:

Date	Depth from Top of Riser (ft)
12 Nov 87	9.0

20 Dec 87	9.7
04 Jan 88	11.4

K. Geotechnical Reports.

1. General. Requirements of the geotechnical report are discussed herein along with required guidelines for the technical writing style. When a separate geotechnical report is not required per contract, the elements herein shall be incorporated into the final contract/task report(s).

2. Report Contents. The geotechnical report shall contain as a minimum:

a. Title page.

b. Disclaimer.

c. DD Form 1473.

d. Abstract.

e. Table of Contents.

f. Background.

g. Regional Geology.

h. Site Geology.

i. Methodology.

j. Significant Conclusions.

k. Geotechnical Analysis.

l. Recommendations.

m. References.

n. Bibliography.

o. Appendices.

(1) Boring Logs.

(2) Well Diagrams.

(3) Well Development.

(4) Water Levels.

(5) Special Problems and Resolution.

(6) Aquifer Testing and Hydraulic Parameters.

(7) Geophysical Data.

(8) Vadose Zone Monitoring data.

(9) Physical Analyses.

(10) Topographic Survey Data.

p. Distribution List.

3. Content Details. Details of the above items are listed below:

a. Title Page. The title page contains the following:

(1) Title.

(2) Author(s).

(3) Company (prime contractor).

(4) Report Date.

(5) Report/Contract Number (provided by USATHAMA).

(6) Distribution Statement (statement indicating the agency authorized to release the report, provided by USATHAMA).

(7) Organization(s) for which report was prepared (typically a Department of the Army installation and USATHAMA).

(8) USATHAMA Address.

b. Disclaimer. The following "DISCLAIMER" shall immediately follow the title page:

"DISCLAIMER"

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products. This report may not be cited for purposes of advertisement."

c. Department of Defense (DD) Form 1473. This form shall be completed by the contractor. The data for blocks 1, 2, 3, 5, and 20 will be furnished by USATHAMA. A blank form is shown in Figure 9.

d. Abstract. The abstract is a summary of purpose, setting, and significant conclusions. This abstract should be more detailed than that given on the DD Form 1473.

e. Table of Contents. This item shall contain:

(1) Major Headings.

(2) Page Numbers.

(3) Figures, Tables, Plates (separately listed).

f. Background. Provide the objective of the geotechnical effort and a discussion of the contractor's corporate involvement within total survey.

g. Regional Geology. Include a discussion of the following topics for adjacent counties and states (as appropriate).

(1) Setting. Include maps and graphics for:

(a) Topography.

(b) Geomorphology.

(c) Physiography.

(d) Drainage.

(2) Stratigraphy. Include a complete, ideal sequence.

(3) Structure and Seismic Activity. Include cross sections.

(4) Hydrology. Include a discussion of surface and groundwater occurrences, drainage area, cross sections, and contour plots of potentiometric surfaces.

h. Site Geology. Discuss site specifics and how the site conforms and/or departs from the regional discussion based upon the knowledge gained from this study.

(1) Setting. Include local aspects of the regional setting.

(2) Stratigraphy. Discuss the sequence encountered.

(3) Structure and Seismic Activity. Include cross sections and local seismic history.

(4) Hydrology. Include hydrostratigraphic cross sections, contour plots, and a discussion of the relationship(s) between surface water and each aquifer encountered.

i. Methodology.

(1) Geotechnical Approach. Discuss literature and field considerations, provide boring and well placement rationale for each drilling site, note drilling locations on a detailed installation map and the largest scale U.S. Geological Survey topographic map depicting the installation.

(2) Drilling techniques. Specify the equipment, water source, procedures, and contractor.

(3) Borehole logging. Describe the procedures and specify the contractor.

(4) Well installation. Describe the materials (casing, screen, bentonite, cement, water, filter pack, etc. (see Table 1), construction procedures, and contractor.

(5) Well development. Specify the equipment, procedures, and contractor.

(6) Geophysical techniques. Provide the purpose, methods and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific), resolution, accuracy, and contractor(s).

(7) Vadose Zone Monitoring. Provide the purpose, particular method(s) and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific) and contractor(s).

(8) Topographic surveying. Specify the equipment, control systems, procedures, and contractor.

(9) Aquifer Tests. Specify the type of tests, literature reference, equipment, general procedure, and contractor.

(10) Physical Analyses. Provide the type of tests, literature references, and contractor.

j. Geotechnical Analysis.

(1) Provide indepth discussions of those geotechnical areas which were significant to the development of the report's conclusions. Describe any uncertainties or extrapolations of data and their relative importance to the conclusions drawn. Provide the data base, references, and actual calculations (in an appendix if over three pages) for quantitative discussions.

(2) Detail the integration of potential contaminant source locations, geologic, hydrologic, and available chemical data. Include how known or estimated groundwater velocities, directions, and chemical quality correspond to known or suspected up-, down-, and cross-gradient contaminant locations. For example, evaluate the occurrence of contaminants at a down-gradient well in terms of most likely up-gradient source, groundwater velocity and direction known or estimated in that area.

(3) Discuss each contaminant site in terms of the geologic, hydrologic, and (when available) chemical data generated by this study. Combine these individual site presentations into a total installation environmental discussion. Relate the installation environmental setting to the regional level. This site to regional development shall be done graphically with narratives to cover key and subtle points.

(4) Present and evaluate the results of any geophysical efforts in terms of design versus actual results, and actual results versus confirmatory/ground truth data; e.g., water levels, chemical analyses, borehole stratigraphy, etc.

(5) Discuss and evaluate the results of any vadose zone monitoring.

(6) Specify and discuss any soil classifications and any other geotechnical data which were changed from the original field descriptions (see III.B.5.c.).

k. Significant Conclusions. Provide summary discussions of those project results which bear upon the intended survey objectives and related areas. Avoid quantitative conclusions based upon qualitative data. Highlight the limitations imposed upon the extrapolation of quantitative conclusions.

l. Recommendations. In addition to any specific recommendations requested within the Statement of Work, the contractor shall recommend those actions (if any) to refine or fill key data gaps and areas of uncertainty relative to the project objective. Additional recommendations should be made for those areas where a change in technique, methodology, or approach could result in a technical or cost benefit in any future efforts at the installation. The COR will specify whether the recommendations shall be included as part of the geotechnical or final report or be provided under a separate cover.

m. References. List by author, title, publication, volume, date, etc., those sources specifically referenced within the geotechnical report.

n. Bibliography. List as above those sources which provided or could provide general project-related data.

o. Appendices. Include data too bulky to be presented within the main body of the report; e.g., extensive tables or figures, or groups of data covering more than three pages. Where these data are in the DMS, they shall be presented in tabular and/or graphic form by the contractor directly from this System. The contractor shall coordinate with the COR to accomplish this requirement.

(1) Boring Logs. Provide legible copies of the "as submitted" field logs, uncorrected by office review and any lab analyses.

(2) Well Diagrams. Provide a detailed graphical presentation for each well with data per contract, to include hole depth, locations of screen, joints, centralizers, top of riser, top of protective casing, cave-in, granular filter pack, bentonite, grout, etc. Include an adjacent staff with appropriate Unified Soil Classification Symbols/rock classification for the entire length of drilled hole. Also graphically detail the protective measures at the well head; protective casing, pickets, caps, locks, etc. Key these sketches to both ground surface (depths below/heights above) and elevation (National Geodetic Vertical Datum of 1929).

(3) Well Development. Provide contractual data in tabular form.

(4) Water Levels. Provide, in tabular form, a listing of water levels (depths and elevations) for each well to include: well number, ground surface elevation, riser height above ground surface (stickup), riser elevation, first encountered water, initial 24-hour level after development, and subsequent static levels measured during the course of the contract. Each level must be annotated as to date of measurement and point from which measured. At least one complete set of static level measurements must be made and included for all project wells over a ten-hour period.

(5) Special Problems and Resolution. Discuss any special geotechnical problems and their resolution. This topic may be addressed in a separate letter to the COR.

(6) Aquifer Testing and Hydraulic Parameters. For the procedures and parameters required by contract, provide a detailed discussion of methodology used, assumptions made, and accuracy measured. Discuss how field conditions varied from those assumed in the method used. Evaluate the values measured against values reported in similar environments and against the setting and manner in which the values of this study were measured. Include references, field data, graphs of field data (e.g., time vs. drawdown plots), sample calculations for each parameter, and a graphical sketch of the relation between field and equation parameters. Present results in tabular form.

(7) Geophysical Data. Provide the data obtained during the study and any lengthy discussions better suited for an Appendix rather than in the main text.

(8) Vadose Zone Monitoring. Provide the data from any monitoring and any detailed discussions more appropriate for Appendices.

(9) Physical Analyses. Provide the references for all tests run. Include the method and procedures for any permeameter tests. Present the results in tabular form. Also, include grain-size graphs. Provide a discussion of these analyses with respect to permeability, both alone and as a comparison with aquifer test results.

(10) Topographic Survey Data. Provide a corrected, legible copy of the field topographic data; and in tabular form, the corrected coordinates and elevation of each surveyed and key feature, including, bores and wells, bench marks, key control points, etc. For each well, include the elevations of the top of the well riser, protective casing, and ground surface. See paragraph III.I. for more guidance. Provide a statement of closure, indicating the amount of error (in feet) to be expected for each set of coordinates and elevations.

p. Distribution List. This list will be provided by the Contracting Officer.

4. Technical Writing Style.

a. Be quantitative. Use single, numerical values or ranges to convey magnitude, size, extent, etc. When ranges are used, denote the most probable value or a narrower, subrange of most probable occurrence. If qualitative terms must be used, define them within a numerical range.

b. Express confidence. Discuss the degree of confidence within the quantitative values generated. This confidence may be a function of field or lab conditions, technique, equipment, practice vs. theory, experience, personal bias, etc. Quantify the degree of confidence for key parameters such as elevations, velocities, permeabilities, porosities, gradients, etc. This shall be done through the use of (a) ranges with a most probable value, or (b) a single number with a plus-or-minus value attached.

c. For each point raised, provide a complete discussion. Do not leave the reader with unanswered questions which could have been naturally anticipated.

d. For maps, cross sections, boring staffs, well sketches, contour plots, etc., provide graphic scales (both vertical and horizontal) and a north arrow, as appropriate. Orient maps, contour plots, etc., with north toward the top of the page/sheet and orient the legend in the same manner as the map. Orient each graphic and its legend so that both can be easily read without rotating the graphic. Expand the graphics to cover the full paper size. Make all graphics fully and easily legible. Avoid any color coding on graphics. Provide vertical scales on both sides of each cross section and a horizontal scale along the base.

e. Adjust groundwater contours for topography (hills and valleys), streams (discharging, recharging), impermeable bedrock, and other obvious expressions of or alterations to the plotted groundwater contours.

f. Number all pages and denote those intentionally left blank.

g. Make sure separate graphics containing similar data agree. Make sure the field data, as corrected, agree with the graphical, tabular, and narrative presentations. Specify and discuss any changes made to the field data.

h. Address the four dimensional aspects of groundwater flow (X, Y, Z components and time) for each aquifer. The use of flow nets to supplement groundwater profiles and contours is desired.

i. Based on presurvey and survey data, provide hydrogeologic cross sections for the installation. These sections should include boring staffs with Unified Soil (and rock) Classification Symbols, summary well diagrams (with screen and seal locations noted), estimated stratigraphic correlation between borings, and estimated groundwater profiling.

j. <u>USE TABULAR FORMATS WHEREVER PRACTICAL</u>.

k. Provide literature/source credits for all data used or modified by the contractor. Credits shall appear in the text, on graphics, and in the list of references.

III.

L. Summary Lists.

1. Procedural and Material Summary. Table 2 denotes those geotechnical procedures and materials requiring specific USATHAMA-COR approval prior to their usage and the expected times for geotechnical evaluation and recommendations.

2. Document Submission Summary. In addition to those items to be submitted for approval per III.L.1., various documents and items discussed in these Geotechnical Requirements are to be submitted to the COR designated office (typically USATHAMA) after a particular action is completed. These materials and their submission times are summarized in Table 3.

M. FIGURES

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:

2. Bentonite Manufacturer:

3. Manufacturer's Address and Telephone Number:

4. Product Description (from package label or attach brochure):

5. Intended Use:

SUBMITTED BY:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer/Date:	A	D
Project Geologist/Date:	A	D

BENTONITE APPROVAL REQUEST
FIGURE 1

WATER APPROVAL REQUEST

Army Installation for Intended Use:

1. Water source:

   Owner:

   Address:

   Telephone Number:

2. Water tap location:

   Operator:

   Address:

3. Type of source:

   Aquifer:

   Well depth:

   Static water level from ground surface:

   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by Owner/Operator:

WATER APPROVAL REQUEST
FIGURE 2

7. Attach results and dates of chemical analyses for past two years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer:	A	D
Project Geologist/Date:	A	D
Project Chemist/Date:	A	D

WATER APPROVAL REQUEST

FIGURE 2

GRANULAR FILTER PACK APPROVAL REQUEST

Army Installation for Intended Use:

1. Filter Material Brand Name:

2. Lithology:

3. Grain Size Distribution:

4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:

6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL: (check one)

Project Officer Name/Date:	A	D
Project Geologist Name/Date:	A	D

GRANULAR FILTER PACK APPROVAL REQUEST

FIGURE 3

BORING LOG GENERAL DATA

Project: GENERAL AAP Boring: 87-14 Page: 1 of 3

Driller & Company: JACK JONES OF ACME Co

Geologist/Logger & Company: J. SMITH OF ACE Co Signature: J Smith

Date Boring Started: 7 Nov 87 Completed: 8 Nov 87

Water Levels (from Ground Surface) Drilling Rig: ABC 20

First Encountered: 7.0' Date: 8 Nov 87

While Drilling: 7.0 Date: 8 Nov 87

At Boring Completion: Not MEAS. Date: 8 Nov 87

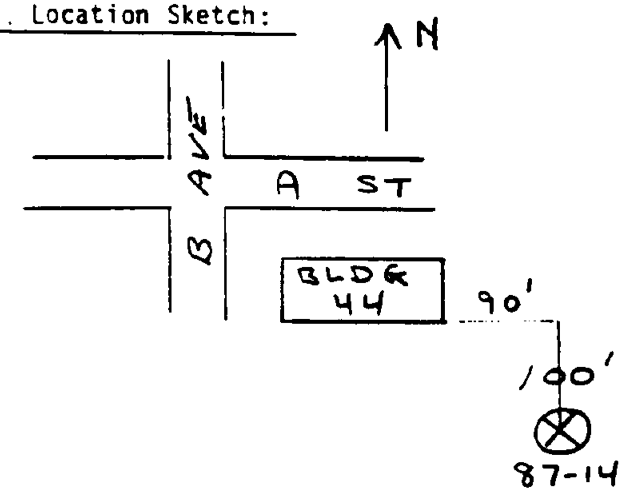
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
1987	Start	End	Start	End		Start	End	Start	End
7 Nov	1500	1700	0	5					
8 Nov	0800	1700	5	18.5					

Abbreviations:

Abbr	Meaning
3x3 1/2, 2x2 1/2	ID & OD OF SPL BBL SAMPLER
STD	- 1 3/8 x 2 STANDARD SAMPLER
R	- RECOVERY
C/B	- CORING INDUCED BREAK
NB	- NATURAL BREAK
LC	- LOST CORE
3x	- 3x3 1/2 SAMPLER
2x	- 2x2 1/2 SAMPLER

Location Sketch:



BORING LOG FORMAT

FIGURE 4

Project: GENERAL AAP | Boring: 37-14 | Page: 2 of 3

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
0	OL	ORG CLAY, SANDY DK RED BRN 5YR 3/4 (MUNSELL) V MOIST, L PLAST ROOTMAT, TOPSOIL	0 S#1 .8	3x3½ 3	NOTES: 1- ALL SAMPLERS DRIVEN BY 140LB HAMMER, FALLING 30" 2. ALL DEPTHS & RECOVERIES IN FT 3. DEPTHS FROM GROUND SURFACE
.8 1	SM	TRANSITIONAL .8 - 1.5 SILTY SAND 20% FINES F-M SAND < 60% F, 20% M		2 R1.5	NOTE 0' 1. DROVE 3X TO 1.5' 2. DROVE 2X TO 3.5' 3. DROVE STD TO 5' 4. SET HSA W/ PLUG TO 5', PULLED PLUG (HSA: 3¼" ID, 7" OD)
2 3		MOIST, LOOSE YEL BRN 10YR 5/4 FAINTLY BEDDED FLAT LYING & X-BEDDED	1.5 S#2 3.0	2x2½ 4 6 R1.5	
4 .6		< 5% SILTY CLAY (CL) LAMINAE FLUVIAL SHARP	3.5 S#3 4.6	STD 2 4 5	
5 6	SP	SAND < 5% FINES F-C SAND { 60% C, 10% M, 25% F V MOIST - SAT NO APPARENT BEDDING LOOSE LT RED BRN 5YR 6/4	5.0 S#4 6.0	R1.5 3X 10 5 R1.0	END 7 NOV 87 START 8 NOV NOTE 5' 1. HOLE DRY + OPEN TO 5'
7		V MOIST SAT FLUVIAL	6.5 S#5 7.5	2X 8	2. DROVE 3X TO 6.5' 3. DROVE 2X TO 8.5' 4. FREE WATER ON SAMPLER & IN SAMPLE 5. MEAS. WATER AT 7.0 W/ ELEC TAPE. AFTER 5 MIN, STILL AT 7.0
8		SHARP		10 R1.0	6. DROVE STD TO 10'
9 10	GP	SANDY GRAVEL 20% F-C SAND 80% F GRAVEL LT RED BRN 5YR 6/4 MED DENSE SAT, NO APP BED FLUVIAL	8.5 S#6 9.8	STD 2 4 8	7. SET HSA W/ PLUG TO 10', PULL PLUG

BORING LOG FORMAT

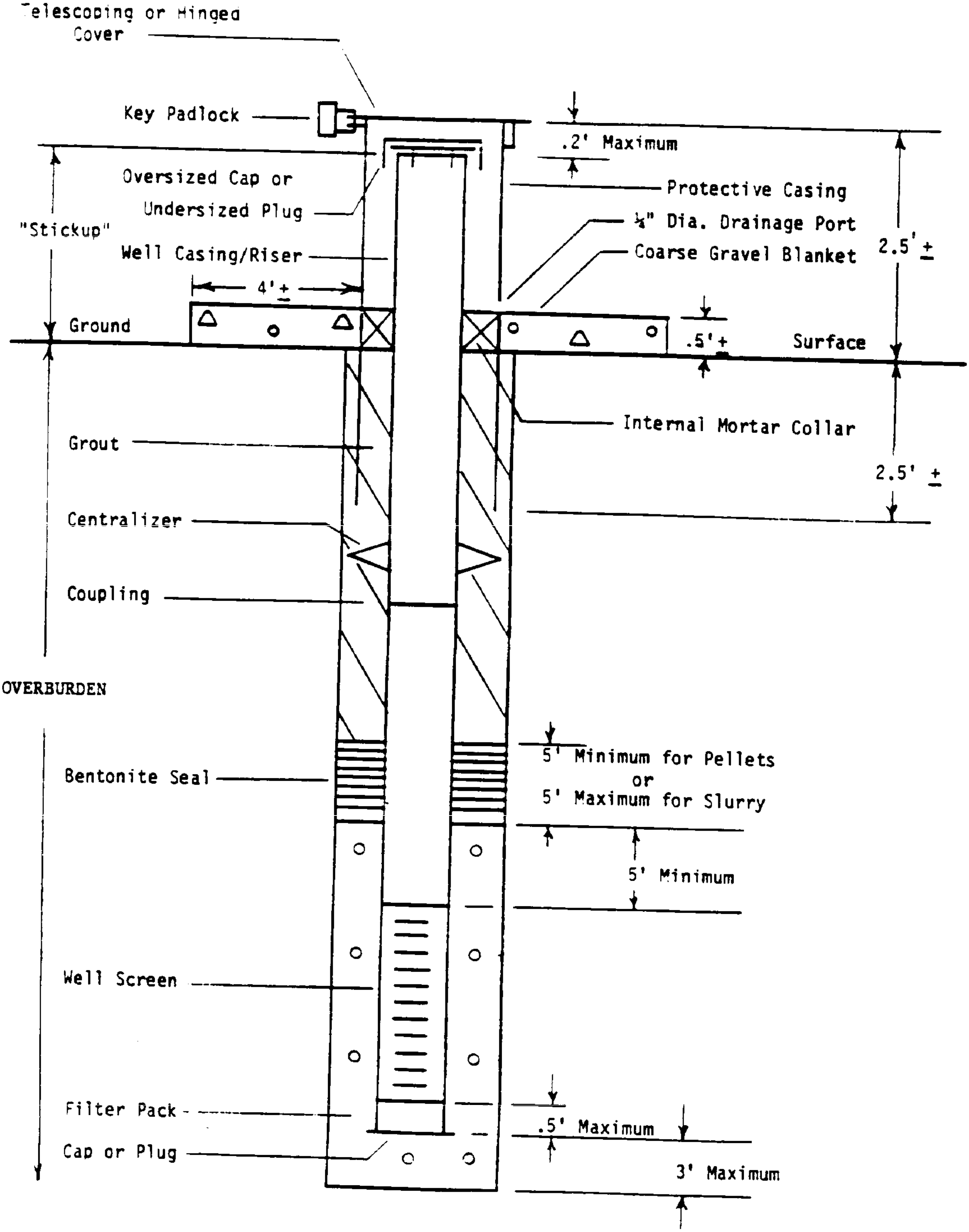
FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 3 of 3

Depth/Elevation (FT)	USCS Symbol/Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
10	GP	SANDY GRAVEL (CONT'D)	S#7 10-.5	3X 100 R.5 10.9	NOTE 10' 1. DROVE 3X TO 10.9' (REFUSAL) 2. PULLED ALL HSA SET 6" CSG TO 11.5' 3. DRILLED w/ ROLLER BIT (6") TO 12.0. WATER LOSS 30 GAL 11.5'-12.0'
11.9	L C	APPROXIMATE TOP OF WEATHERED ROCK LIMESTONE (LM) BASED ON CUTTINGS 1.1' LOST DUE TO DRILLING METHOD		12.0	
12	L C	LM, .5 LOST DUE TO WEATHERING & FRACTURES	12.5		
13, 14		TOP OF SL. WEAT. ROCK C1B LIMESTONE SANDY (SILICEOUS) FOSSILIFEROUS, NUMEROUS CORALS & GASTROPODS C1B THIN, HORIZONTAL BEDDING	Box 1 of 1	RUN #1 R1.5 14.0	NOTE 12 1. START CORE RUN #1 AT 12' w/ 4" DOUBLE TUBE & DIAM. BOT. DISCH. BIT 2. RUN #1 40 GAL LOST 12-12.5 0 LOST 12.5-14 SOUNDED HOLE 14.0'
15, 16, 17		NB YEL BRN 10YR 5/4 HARD NB WELL CEMENTED NB DENSE-COARSE GRAINED SCAT (<5%) TIGHT 45° FRACTURES C1B NO STAINING SOLID, LOW PRIMARY & SECONDARY PERM. ST. GEORGE FM	18.0	RUN #2	NOTE 14 1. RUN #2, COMPLETE, WATER LOSS 18-18.5 (50 GAL)., SH 18.5
18	L C	.5' LOST LM BADLY FRACTURED	18.5	R4.5 18.5	NOTE 18.5 1. TOO FRACTURED TO CORE, USE GEAR BIT TO 30', 2. LOST 500 GALS 3. HOLE OPEN TO 30' 4. SET WELL, PULLED ALL CASING END 8 NOV 87
.5		11.5' LOST, HIGHLY FRAC. LM (CUTTINGS) V. ROUGH DRILLING	S# 8		
30		BOTTOM OF HOLE 30.0			

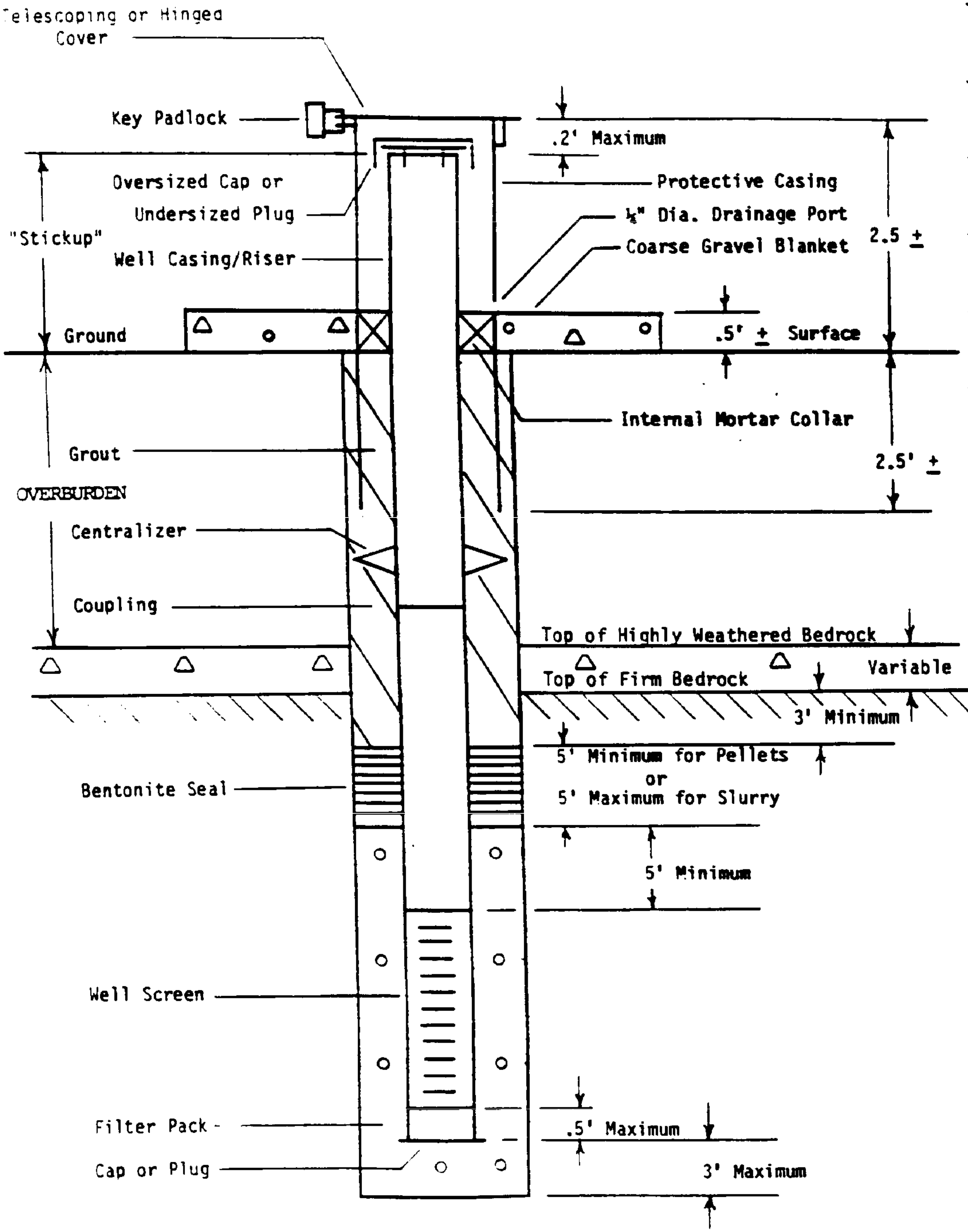
BORING LOG FORMAT

FIGURE 4



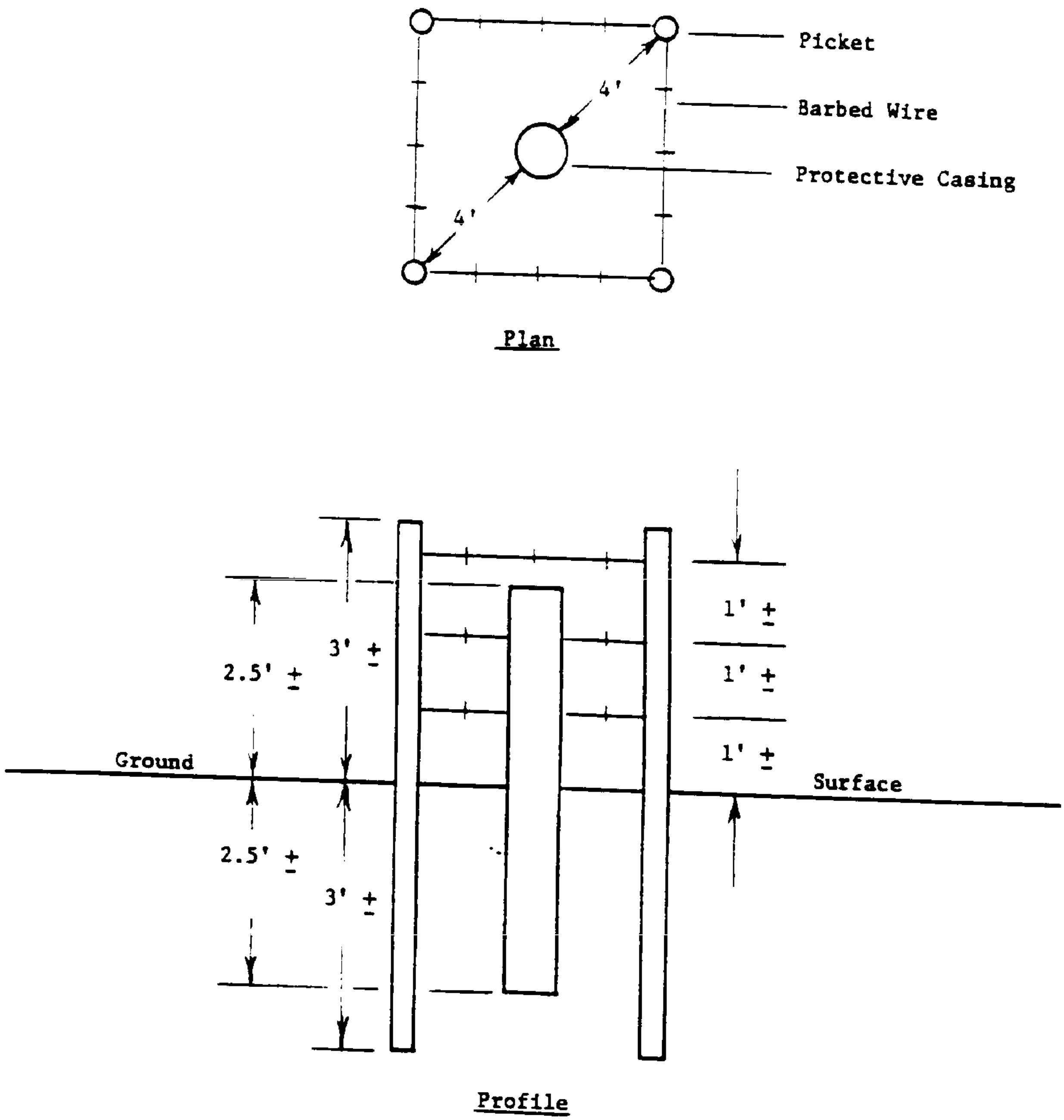
SCHEMATIC CONSTRUCTION OF
OVERBURDEN WELL

FIGURE 5

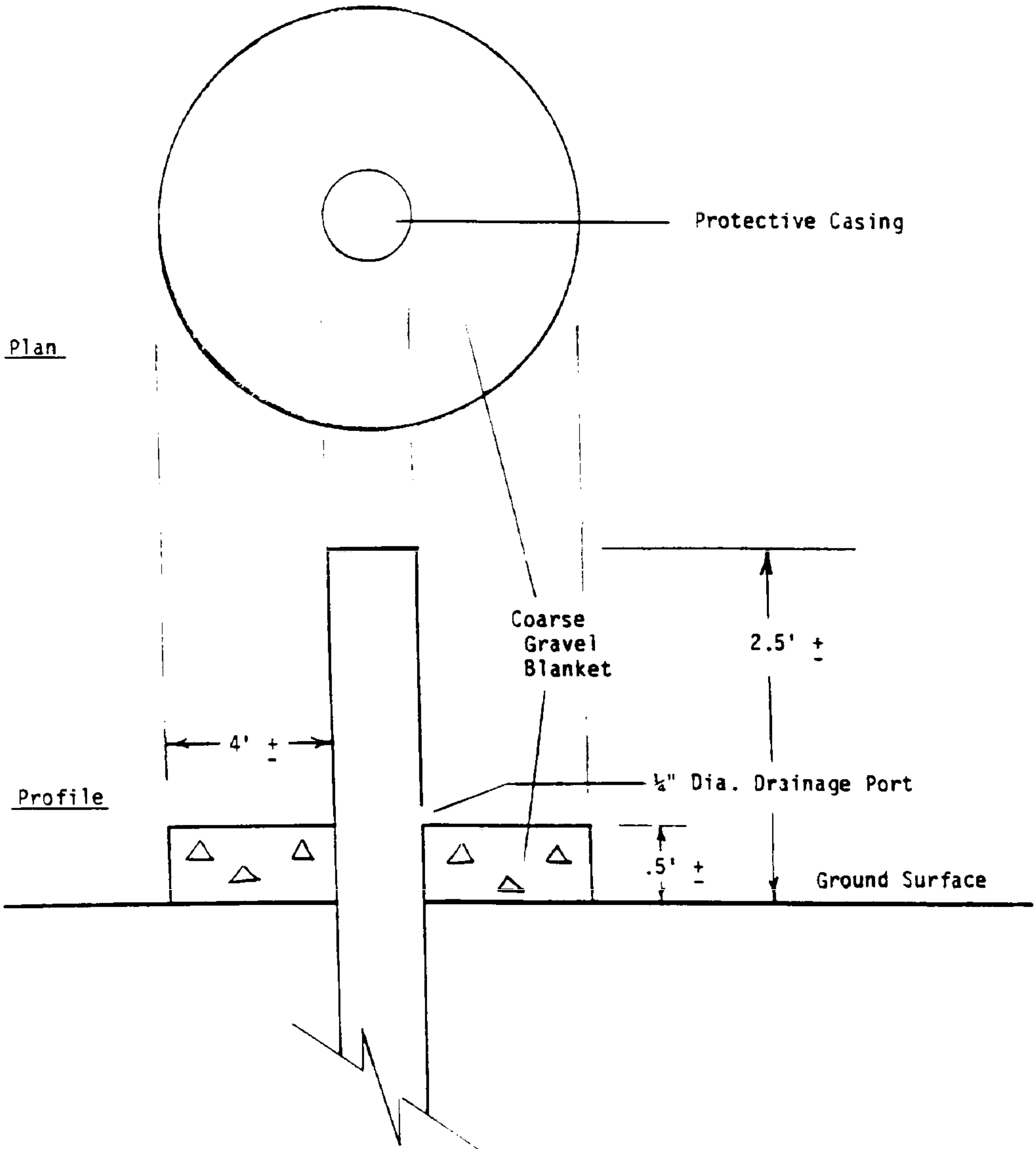


SCHEMATIC CONSTRUCTION OF
BEDROCK WELL

FIGURE 6



PICKET PLACEMENT AROUND WELLS
FIGURE 7



COARSE GRAVEL BLANKET LAYOUT

FIGURE 8

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION / 6b. OFFICE SYMBOL (*If applicable*)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (*City, State, and ZIP Code*)	7b. ADDRESS (*City, State, and ZIP Code*)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION / 8b. OFFICE SYMBOL (*If applicable*)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*)	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (*Include Security Classification*)

12. PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED FROM ______ TO ______	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)

19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

DD FORM 1473

FIGURE 9

Page 1 of 2

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (*Include Area Code*) / 22c. OFFICE SYMBOL

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SECURITY CLASSIFICATION OF THIS PAGE

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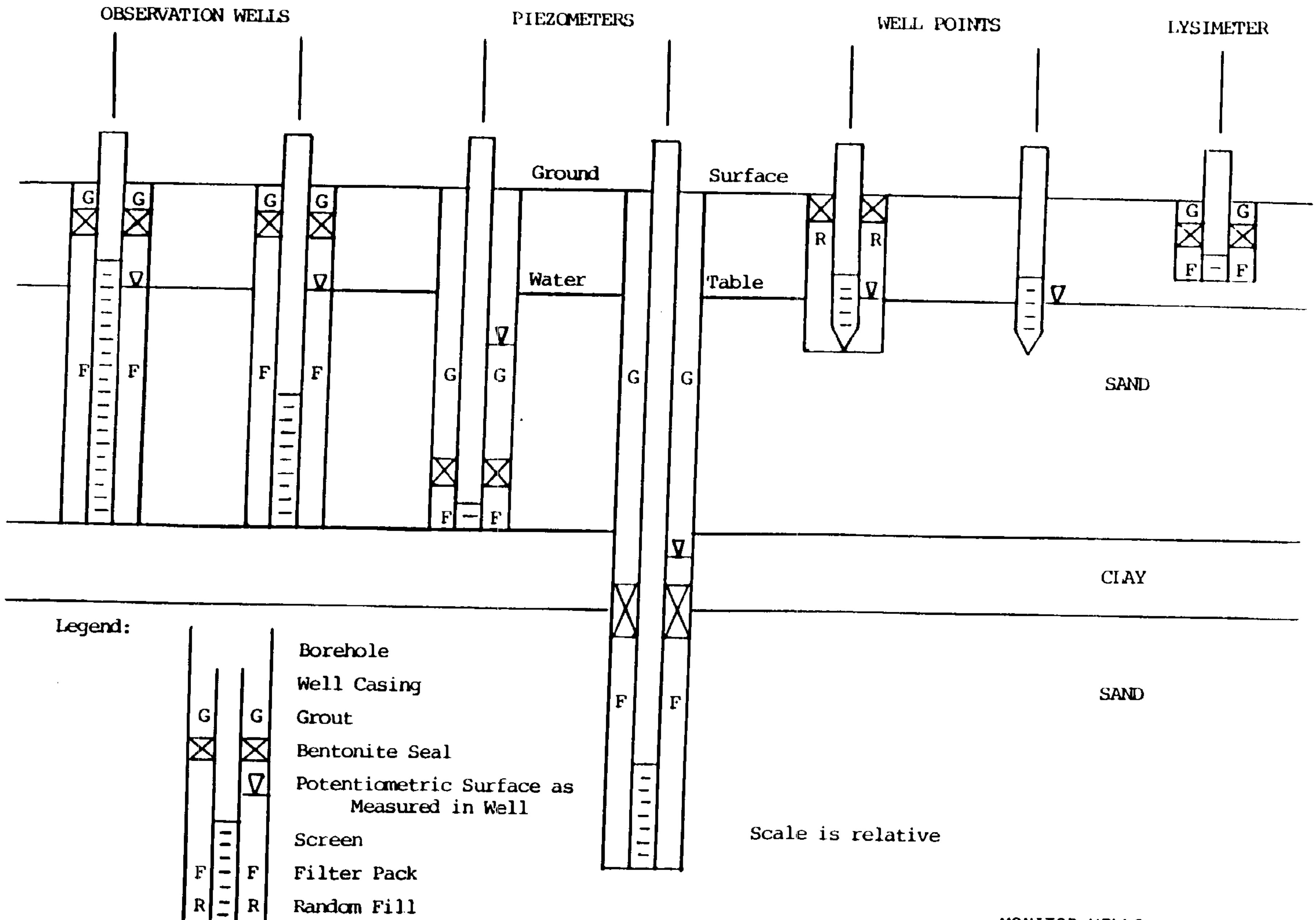
FIGURE 9

Page 2 of 2



MONITOR WELLS
FIGURE 10

MAP CODING FORM

Installation GP Site Type BORE Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: WELL
Pointer Site Id: 87-14
Aquifer id: PALEO

Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (BORE)

FIGURE 11

MAP CODING FORM

Installation GP Site Type WELL Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: BORE Pointer Site Id: 87-14
Aquifer id: PALEO

Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (WELL)

FIGURE 12

INST	FILE TYPE	LAB	INITIALS
GP	GFD	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
BORE	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	GRDWT	01			7.0	FT	
11/08/87	DBRK	01			11.9	FT	
11/08/87	DPTOT	01			30.0	FT	
11/07/87	USCS	01	0.0	.8		FT	OL
11/07/87	USCS	01	0.8	3.8		FT	SM
11/08/87	USCS	01	4.6	3.4		FT	SP
11/08/87	USCS	01	8.0	3.9		FT	GP
11/08/87	USCS	01	11.9	18.1		FT	LMSN
/ /							

FIELD DRILLING FILE CODING SHEET

FIGURE 13

INST	FILE TYPE	LAB	INITIALS
GP	GWC	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
WELL	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	STKUP	01			2.3	FT	
11/08/87	BSEAL	01			5.0	FT	
/ /	CASE	01			25.0	FT	
/ /	CASED	01			.33	FT	
/ /	DPTOT	01			30.0	FT	
/ /	GFILT	01			10.0	FT	
/ /	GROUT	04			15.0	FT	
/ /	SCREN	02			5.0	FT	
/ /							

WELL CONSTRUCTION FILE
CODING SHEET
FIGURE 14

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GGS	AC	JS

UNITS
FT

GROUND WATER STABILIZED *

SITE TYPE	SITE ID	DATE	DEPTH
WELL	87-14	11/12/87	6.7
WELL	87-14	12/20/87	7.4
WELL	87-14	01/04/88	9.1
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	

* - Depth measured from ground surface

GROUNDWATER STABILIZED FILE

CODING SHEET

FIGURE 15

N. TABLES

TABLE 1

WELL CONSTRUCTION MATERIALS

Material (Example Entries)	Brand/Description (Example Entries)	Source/Supplier (Example Entries)
PVC Casing	4.0" ID, Schedule 40, flush threaded; 2" ID, Schedule 40, flush threaded.	ABC Mfg; Aville, Minnesota
PVC Screen	.05" slot, 4.0" ID, Schedule 40, flush threaded, .02" slot, 2" ID, Schedule 40, flush threaded	ABC Mfg; Aville, Minnesota
Bentonite (drilling fluid and grout)	Tru-gel	A. O. Bentonite, Bville, Wyoming
Granular Bentonite (seal)	Gran-Bent	White Mud, Cville, Montana
Bentonite Pellets (seal)	(No brand name available)	PELBENT, Dville, Utah
Sand (filter pack)	8-12 silica sand	State Sand, Mville, Colorado; supplier: EFG Co. Eville, Utah
Cement (grout)	Portland Type II	A. Lumber Co., Eville, Utah
Drilling Water	St. Peter Sandstone	Production Well #1, Tap at well house General AAP
Drilling Rod Lubricant	Slick Turn	Oil Products Co., Fville, Texas
Air Compressor Oil	Oil #40	Oil Products Co., Fville, Texas

TABLE 2

PROCEDURAL AND MATERIAL APPROVAL SUMMARY

Items Requiring Approval	Reference Section	Time for Approval	Turn Around Time for Geotechnical Evaluation and Recommendation
Drilling Method	III.A.1.c.	Prior to contract/task award	During Proposal/ Bid Evaluation
Air Usage	III.A.2.	Prior to contract/task award	During Proposal/ Bid Evaluation
Bentonite	III.A.10.a.	Prior to drilling equipment arrival onsite	6 Working Days
Water	III.A.10.b.	Prior to drilling equipment arrival onsite	3 Calendar Weeks
Abandonment	III.A.11.	Prior to casing removal or backfilling	4 Consecutive Hours
Borehole Fluids, Cuttings, and Well Water Disposal	III.A.16.	Prior to technical plan acceptance	During Plan Evaluation
Time of Well Installation	III.C.1.	Prior to drilling	3 Working Days
Well Screen and Casing Materials	III.C.2.a.	Prior to contract/task award	During Proposal/ Bid Evaluation
Granular Filter Pack	III.C.5.a.	Prior to drilling	8 Working Hours
Protective Casing, Exceptions	III.C.8.a	Prior to drilling	6 Working Days
Geophysical Procedures	III.G.	Prior to use	Time not specified
Vadose Zone Monitoring	III.H.	Prior to use	Time not specified

TABLE 3

CONTRACTOR DOCUMENT/ITEM SUBMISSION SUMMARY

Document/Item	Reference Section	Submission Time	Submission To
Geotechnical Requirements (modified per contract)	II.A.	With Technical Plan (or equivalent document)	USATHAMA-COR
Licenses of Surveyor and Driller	III.A.5.	With Technical Plan (or equivelent document)	USATHAMA-COR
Submissions to State and/or local authorities	III.A.5.	As required	State and/or local offices coordinated through USATHAMA
Abandonment memorandum (written)	III.A.11.	Within 5 working days of telephonic request	Contracting Officer through USATHAMA
Abandoned boring and/or well record	III.A.11.	Within 3 working days of abandonment	USATHAMA-COR
Soil physical testing results	III.A.12.d.	Within 10 working days of final test	USATHAMA-COR
Rock core photography	III.A.13.	Within 2 weeks of last coring	USATHAMA-COR
Boring logs	III.B.2.	Within 3 working days after boring completion or instrumentation completely installed	USATHAMA-COR
Boring log abbreviations, general legend	III.B.5.v.	With first or last log, as appropriate	USATHAMA-COR
Two keys to padlocks	III.C.8.c.(8)	Upon completion of last well placement	Installation Representative and USATHAMA
Well diagram	III.C.12.c.	Within 3 working days of well/protective measure completion	USATHAMA-COR

TABLE 3 (Cont'd)

Document/Item	Reference Section	Submission Time	Submission To
Well development record	III.D.2.	Within 3 working days after development	USATHAMA-COR
Well development water sample	III.D.10.	Within 3 working days after developing that well	USATHAMA-designated individual
Geotechnical Report(s)	III.K.	As required per contract or task	Contracting Officer through USATHAMA

APPENDIX B

ESE CHAIN OF CUSTODY FORMS

ESE FIELD LOGSHEET AND LABEL - A Description

Refer to the attached example.

1. Date of generation of the field group and logsheet.

2. FIELD GROUP - This is an alphanumeric label, assigned by the laboratory coordinator, that identified this particular sample effort. The name must not be altered once the field group has been set-up.

3. PROJECT NUMBER - The first seven digits represent a unique numeric identifier for the project, the four digits suffix identifies a discrete analytical task performed as part of that project.

4. PROJECT NAME - Client's name and/or project descriptor.

5. LAB COORD. - The laboratory Coordinator (LC) responsible for this field group.

6. ESE # - The field group sample sequence number, an integer that is combined with the field group name (i.e., FTBLS1*199) to serve as an unique identifier for that sample. The number should not be altered once set-up.

7. SITE/STA - The site or station identification number. This alphanumeric label is used to identify the physical location or sampling point (well, test bore, sediment, etc.) where the sample was obtained. This ID may be altered to reflect changes in the field and should be limited to 9 characters.

8. HAZ? - The hazard code which alerts field personnel if special precautions should be taken when handling and processing the sample. The key to these codes are printed on the logsheet itself in the section labeled "NOTE".

9. FRACTIONS - These codes inform sampling personnel how much of the matrix is required, its storage requirements, type of container and method of preservation. Each fraction collected and shipped should be circle by sample collection personnel. See "Key to Fraction Codes" for more information.

10. DATE - Date of collection.

11. TIME - Time of collection.

12. PARAMETER LIST - an alphanumerically labeled list of the analysis and procedures that are to be performed on the sample as requested by the LC.

13. Record FIELD DATA in this area, including such things as field pH and conductivity, or Army parameters, as appropriate.

13A. Record the Sequence Number (ESE # [6.]) of the sample that was replicated. This is very important in the lab's review of the data and subsequent submittal to the Army's database.

14. These three blank lines are for signatures of individuals who are handling the samples to document the chain of custody. Sampler signs line 1, left side, and also initials label. When samples are relinquished to Fed. Ex. (or other courier) record the airbill number in the "REC'D BY" space.

15. SAMPLER: NEXT SHIPMENT - Record date of next shipment of samples in this field group (if any).

16. NUMBER SAMPLES - Record number of samples that will be sent in the next shipment (if any).

Items 17 through 20 will be recorded by the Sample Custodian (at the laboratory).

17. CUSTODY SEALS INTACT - Indicates whether or not custody tapes are intact (if any) when received at the laboratory.

18. SAMPLES ICED - Indicates whether or not the samples were received at the laboratory on ice.

19. PRESERVATIONS AUDITED? - Indicates whether or not the preservations were performed and/or performed correctly.

20. PROBLEMS? - Problems with the sample shipment, receipt, packing, and/or preservations (if any) would be noted here.

nvironmental Science and Engineering 05-18-90 (1) *** FIELD LOGSHEET *** FIELD GROUP: (2) SIADW2

(3) PROJECT NUMBER 3904079 0201 (4) PROJECT NAME: JMM/SIERRA ARMY DEPOT (5) LAB COORD. JACKIE HARGROVE

SE # (6)	SITE/STA (7)	HAZ? (8)	FRACTIONS (CIRCLE) (9)	DATE (10)	TIME (11)	PARAMETER LIST (12)	FIELD PH STD UNITS (13)	SP COND UMHOS/CM	H2O TEMP C	DEPTH FEET	S TECH
*1	DMO-03-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*2	DMO-04-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*3	DMO-05-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*4	DMO-GW-RB		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*5	DMO-GW-DP# (13A)		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*6	ALF-01-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPCPW					
*7	ALF-02-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPCPW					

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD: IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN COMPLETED LOGSHEETS WITH SAMPLES TO Environmental Science and Engineering, Inc.

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	VIA:	REC'D BY (NAME/ORGANIZATION/DATE/TIME)
1 (14)		
2		
3		

SAMPLER: MORE SAMPLES TO BE SHIPPED? (75) IF YES, ANTICIPATED # (76) TO SHIP ON / /

SAMPLE CUSTODIAN: Custody Seals Intact? (17) Samples Iced? (18) Preservations Audited? (19) Problems? (20)

Environmental Science and Engineering 03-07-90 *** FIELD LOGSHEET *** FIELD GROUP: SIADS1
PROJECT NUMBER 3904079 0201 PROJECT NAME: JMM/SIERRA ARMY DEPOT LAB COORD. JACKIE HARGROVE

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	SAM TYPE	SITE TYPE	DEPTH FEET	S TECH	INSTAL SAMPLE
*1	DMO-06-SB		SS SS SV SV			DMOTVBP+6	SO	BORE			SA
*2	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*3	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*4	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*5	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*6	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*7	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*8	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*9	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*10	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*11	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*12	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*13	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*14	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*15	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*16	DMO-06-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA
*17	DMO-07-SB		SS SS SV SV			DMOTVBP+6	SO	BORE			SA
*18	DMO-07-SB		SS SS SV SV			DMOTVBP	SO	BORE			SA

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD: IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN COMPLETED LOGSHEETS WITH SAMPLES TO Environmental Science and Engineering, Inc.

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME) VIA: REC'D BY (NAME/ORGANIZATION/DATE/TIME)

1

2

3

SAMPLER: MORE SAMPLES TO BE SHIPPED? ___ IF YES, ANTICIPATED # ___ TO SHIP ON __/__/__
SAMPLE CUSTODIAN: Custody Seals Intact? ___ Samples Iced? ___ Preservations Audited? ___ Problems? ___

Environmental Science and Engineering 05-18-90 *** FIELD LOGSHEET *** FIELD GROUP: **SIADW2**

PROJECT NUMBER 3904079 0201 PROJECT NAME: JMM/SIERRA ARMY DEPOT LAB COORD. JACKIE HARGROVE

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	FIELD PH STD UNITS	SP COND UMHOS/CM	H2O TEMP C	DEPTH FEET	S TECH
*1	DMO-03-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*2	DMO-04-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*3	DMO-05-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*4	DMO-GW-RB		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*5	DMO-GW-DP#		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPW					
*6	ALF-01-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPCPW					
*7	ALF-02-MWA		LC VP, LC VP, B MS VP, C MS Z, EC NF Z, EC VP, EC VP, F			MMVBPCPW					

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE, TIME, FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN COMPLETED LOGSHEETS WITH SAMPLES TO Environmental Science and Engineering, Inc.

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	VIA:	REC'D BY (NAME/ORGANIZATION/DATE/TIME)
1		
2		
3		

SAMPLER: MORE SAMPLES TO BE SHIPPED? ___ IF YES, ANTICIPATED # ___ TO SHIP ON __/__/__

SAMPLE CUSTODIAN: Custody Seals Intact? ___ Samples Iced? ___ Preservations Audited? ___ Problems? ___

Master CA 2/91LB

ESE KEY TO FRACTION CODES 1/91

	CODE	PRESERVATIVE	CONTAINER	ANALYSIS TYPE	HOLDING TIMES
AIR:	AA	4-Deg-C	Various	Various	Various
	AO	Exclude Light	Sorbent	Organic	14 Days
	AV	Exclude Light	Charcoal	Volatiles	14 Days
	FL	Keep Upright	Cassette	Various	Various
SOILS:	SS	4-Deg-C	G, 500 mL	All excl. Vol.	7-28 Days
	SV	4-Deg-C	G, 60 mL	Volatiles	7-14 Days
WATER:	AL	4-Deg-C(T)	G,2x60 mL*	Aldicarb	14 Days
	B	4-Deg-C;NaOH,pH>12	P, 1-4 L**	Cyanides	14 Days
	C	4-Deg-C	P, 1-4 L	Var.Inorganic	1-28 Days
	CL	4-Deg-C	G, 1-4 L	Chlorophyll	1 Day
		(Pref'd Filtered & Frozen at <0-Deg-C)			
	EC	4-Deg-C(T)g	G, 1 L	Chlor'd Pests	7 Days
	ED	4-Deg-C(T)	G,2x60 mL*	EDB, DBCP	14 Days
	F	-	P, 4 L	Collection prior to Field Filtering	
	FI	4-Deg-C(T)	G, 1 L	GC/FI Organic	7 Days
	FM	Formaldehyde	P/G,500mL	"Quats"	28 Days
	FP	4-Deg-C(T)	G,3x60 mL*	GC/FP Organic	14 Days
	H	Zn-Acet;NaOH,pH>10	P, 1 L	Sulfides	7 Days
	HB	4-Deg-C(T)	G, 1 L	Chlor'd Herbs	7 Days
	LC	4-Deg-C	G, 1 L	HPLC Organics	7 Days
	M	4-Deg-C(T)	P, 250 mL	Bacteriologic	6 Hours
	MS	4-Deg-C(T)	G, 1 L	GCMS Extr.Org.	7 Days
	N	HNO_3,pH<2	P, 1 L	Metals (Total)	180 Days
				Mercury (Total)	28 Days
	NF	HNO_3,pH<2	P, 1 L	Metals (Dissolved)	180 Days
				Mercury (Dissolved)	28 Days
	NC	4-Deg-C	G, 1 L	Nitrocellulose	7 Days
	NP	4-Deg-C	G, 1 L	GC/NP Organic	7 Days
	O	4-Deg-C;H_2SO_4,pH<2	G, 1 L	Oil&Grease, TRPH	28 Days
	OD	4-Deg-C	G, 1 L	Odor	2 Days
	R	HNO_3,pH<2	P, 1-4 L	Radionuclides	180 Days
	S	4-Deg-C;H_2SO_4,pH<2	P, 1 L	Nutrients	28 Days
	(UP)	4-Deg-C(T)	G, 1 L	Pest(Antiq'd)	7 Days
	V	4-Deg-C(T)	G,3x60 mL*	Halogen, Vols	14 Days
	VP	4-Deg-C;HCL,pH<2(T)	G,3x60 mL*	Aromatic Vols	14 Days
	(W)	4-Deg-C(T)	G, 1 L	Orgs, FPD Extr's	7 Days
	X	4-Deg-C(S)	G,2x250mL*	TOX(USATHAMA)	7 Days
	XP	4-Deg-C;H_2SO_4,pH<2(S)	G,2x250mL*	TOX	7 Days
	Z	4-Deg-C;H_2SO_4,pH<2	G, 1 L	Total Phenols	28 Days
OTHER:	OL	None	G,10-100mL	Organic-Oil	14 Days
	TS	-20-Deg-C	Various	Frozen Tissue	Various

FOOTNOTES: (T) - Add Sodium Thiosulfate ($Na_2S_2O_3$) If Res.Cl Present (0.25g/L)
(S) - Add Sodium Sulfite (Na_2SO_3) If Res.Cl Present (0.1M, 1 mL/L).
* - Volatiles Bottles (VOAs) With Teflon-Lined Rubber Septa.
** - Test for presence of sulfide and follow EPA procedures (below) as necessary.

INSTRUCTIONS FOR SAMPLING AND SHIPPING

- Plastic (P) containers may be rinsed with sample; Do not rinse Glass (G)
- Fill completely, especially for volatiles (fill these slowly; achieve positive meniscus; cap; invert; check for air bubbles; top off if needed.
- Preserve with reagents provided as instructed above (VP's are pre-preserved)
- Special cyanide preservations: When presence of sulfide is indicated by a positive spot test with lead acetate paper, preservation consists of: 1) precipitation with cadmium nitrate until a negative test is obtained; 2) filtration of the precipitate; and 3) addition to NaOH to pH > 12.
- Fill-out logsheet/chain-of-custody. Indicate: Sample Number (*) and fractions collected; dates/times of collection & shipment; appropriate field notes; Be sure to sign bottom of each page where and as indicated.
- Ship with bagged ice in ice-chest by express carrier to lab coordinator's attention.

Source: ESE, 1991.

Figure 5-5
STANDARDIZED SAMPLE PRESERVATION CODES

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

APPENDIX C

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
			Analyses Needed										
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2-120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
Main Demolition	Excavation Pits												
Area (SWMU-1),	NEP-01-001	2					2			2		2	
Cluster Bomb	NEP-01-002	2					2			2		2	
Detonation Area	NEP-01-003	2					2			2		2	
(SWMU-1a), and	NEP-01-004	2					2			2		2	
Propellent Burn Pans	NEP-01-005	2					2			2		2	
(SWMU-1d)(a)	NEP-01-006	2					2			2		2	
	NEP-01-007	2					2			2		2	
	NEP-01-008	2					2			2		2	
	NEP-01-009	2					2			2		2	
	NEP-01-010	2					2			2		2	
	NEP-01-011	2					2			2		2	
	NEP-01-012	2					2			2		2	
	NEP-01-013	2					2			2		2	
	NEP-01-014	2					2			2		2	
	NEP-01-015	2					2			2		2	
	NEP-01-016	2					2			2		2	
	NEP-01-017	2					2			2		2	
	NEP-01-018	2					2			2		2	
	NEP-01-019	2					2			2		2	
	NEP-01-020	2					2			2		2	
	NEP-01-021	2					2			2		2	
	NEP-01-022	2					2			2		2	
	NEP-01-023	2					2			2		2	
	NEP-01-024	2					2			2		2	
	NEP-01-025	2					2			2		2	
	NEP-01-026	2					2			2		2	
	NEP-01-027	2					2			2		2	
	NEP-01-028	2					2			2		2	
	NEP-01-029	2					2			2		2	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
			Analyses Needed										
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 - 120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
SWMU-1, SWMU-1a, and SWMU-1d (continued)	NEP-01-030	2					2			2		2	
	NEP-01-031	2					2			2		2	
	NEP-01-032	2					2			2		2	
	NEP-01-033	2					2			2		2	
	NEP-01-034	2					2			2		2	
	NEP-01-035	2					2			2		2	
	NEP-01-036	2					2			2		2	
	NEP-01-037	2					2			2		2	
	NEP-01-038	2					2			2		2	
	NEP-01-039	2					2			2		2	
	NEP-01-040	2					2			2		2	
	NEP-01-041	2					2			2		2	
	NEP-01-042	2					2			2		2	
	NEP-01-043	2					2			2		2	
	NEP-01-044	2					2			2		2	
	NEP-01-045	2					2			2		2	
	NEP-01-046	2					2			2		2	
	NEP-01-047	2					2			2		2	
	NEP-01-048	2					2			2		2	
	NEP-01-049	2					2			2		2	
	NEP-01-050	2					2			2		2	
	NEP-01-051	2					2			2		2	
	NEP-01-052	2					2			2		2	
	NEP-01-053	2					2			2		2	
	NEP-01-054	2					2			2		2	
	NEP-01-055	2					2			2		2	
	NEP-01-056	2					2			2		2	
	NEP-01-057	2					2			2		2	
	NEP-01-058	2					2			2		2	
	NEP-01-059	2					2			2		2	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Analyses Needed Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
SWMU-1, SWMU-1a, and SWMU-1d (continued)	NEP-01-060	2					2			2		2	
	NEP-01-061	2					2			2		2	
	NEP-01-062	2					2			2		2	
	NEP-01-063	2					2			2		2	
	NEP-01-064	2					2			2		2	
	NEP-01-065	2					2			2		2	
	NEP-01-066	2					2			2		2	
	NEP-01-067	2					2			2		2	
	NEP-01-068	2					2			2		2	
	NEP-01-069	2					2			2		2	
	NEP-01-070	2					2			2		2	
	NEP-01-071	2					2			2		2	
	NEP-01-072	2					2			2		2	
	NEP-01-073	2					2			2		2	
	NEP-01-074	2					2			2		2	
	NEP-01-075	2					2			2		2	
	NEP-01-076	2					2			2		2	
	NEP-01-077	2					2			2		2	
	NEP-01-078	2					2			2		2	
	NEP-01-079	2					2			2		2	
	NEP-01-080	2					2			2		2	
	NEP-01-081	2					2			2		2	
	NEP-01-082	2					2			2		2	
	NEP-01-083	2					2			2		2	
	NEP-01-084	2					2			2		2	
	NEP-01-085	2					2			2		2	
	NEP-01-086	2					2			2		2	
	NEP-01-087	2					2			2		2	
	NEP-01-088	2					2			2		2	
	NEP-01-089	2					2			2		2	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
							Analyses Needed						
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
SWMU-1, SWMU-1a, and SWMU-1d (continued)	NEP-01-090	2					2			2		2	
	NEP-01-091	2					2			2		2	
	NEP-01-092	2					2			2		2	
	NEP-01-093	2					2			2		2	
	NEP-01-094	2					2			2		2	
	NEP-01-095	2					2			2		2	
	NEP-01-096	2					2			2		2	
	NEP-01-097	2					2			2		2	
	NEP-01-098	2					2			2		2	
	NEP-01-099	2					2			2		2	
	NEP-01-100	2					2			2		2	
	NEP-01-101	2					2			2		2	
	NEP-01-102	2					2			2		2	
	NEP-01-103	2					2			2		2	
	NEP-01-104	2					2			2		2	
	NEP-01-105	2					2			2		2	
	NEP-01-106	2					2			2		2	
	NEP-01-107	2					2			2		2	
	NEP-01-108	2					2			2		2	
	NEP-01-109	2					2			2		2	
	NEP-01-110	2					2			2		2	
	NEP-01-111	2					2			2		2	
	NEP-01-112	2					2			2		2	
	NEP-01-113	2					2			2		2	
	NEP-01-114	2					2			2		2	
	NEP-01-115	2					2			2		2	
	NEP-01-116	2					2			2		2	
	NEP-01-117	2					2			2		2	
	NEP-01-118	2					2			2		2	
	NEP-01-119	2					2			2		2	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
			Analyses Needed										
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
SWMU-1, SWMU-1a,	NEP-01-120	2					2			2		2	
and SWMU-1d	NEP-01-121	2					2			2		2	
(continued)	NEP-01-122	2					2			2		2	
	NEP-01-123	2					2			2		2	
	NEP-01-124	2					2			2		2	
	NEP-01-125	2					2			2		2	
	Deep Soil Borings												
	NSB-01-001	7					7			7		7	
	NSB-01-002	7					7			7		7	
	NSB-01-003	7					7			7		7	
	NSB-01-004	7					7			7		7	
	NSB-01-005	7					7			7		7	
Propellent Burn Pans	Excavation Pits												
(SWMU-1b) and	NEP-01-126	2					2			2		2	
Trash Burn Pits	NEP-01-127	2					2			2		2	
(SWMU-1c) (b)	NEP-01-128	2					2			2		2	
	NEP-01-129	2					2			2		2	
	NEP-01-130	2					2			2		2	
	NEP-01-131	2					2			2		2	
	NEP-01-132	2					2			2		2	
	NEP-01-133	2					2			2		2	
	NEP-01-134	2					2			2		2	
	NEP-01-135	2					2			2		2	
	NEP-01-136	2					2			2		2	
	NEP-01-137	2					2			2		2	
	NEP-01-138	2					2			2		2	
	NEP-01-139	2					2			2		2	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
							Analyses Needed						
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 - 120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
Propellent Burn Pans	NEP-01-140	2					2			2		2	
(SWMU-1b) and Trash	NEP-01-141	2					2			2		2	
Burn Pits (SWMU-1c)	NEP-01-142	2					2			2		2	
(continued)	NEP-01-143	2					2			2		2	
	NEP-01-144	2					2			2		2	
	NEP-01-145	2					2			2		2	
	NEP-01-146	2					2			2		2	
	NEP-01-147	2					2			2		2	
	NEP-01-148	2					2			2		2	
	NEP-01-149	2					2			2		2	
	NEP-01-150	2					2			2		2	
	NEP-01-151	2					2			2		2	
	NEP-01-152	2					2			2		2	
	NEP-01-153	2					2			2		2	
	NEP-01-154	2					2			2		2	
	NEP-01-155	2					2			2		2	
	Soil Borings												
	NSB-01-006	7					7			7		7	
	NSB-01-007	7					7			7		7	
	NSB-01-008	7					7			7		7	
Box Elder Wash	Surface Soil												
Wash (SWMU-1)	Samples												
	NSS-01-001	1					1			1		1	
	NSS-01-002	1					1			1		1	
	NSS-01-003	1					1			1		1	
	NSS-01-004	1					1			1		1	
	NSS-01-005	1					1			1		1	
	NSS-01-006	1					1			1		1	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	Analyses Needed										
			VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 - 120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
Sandblast Area (SWMU-4)	Surface Soil Samples												
	NSS-04-001	1					1			1		1	
	NSS-04-002	1					1			1		1	
	NSS-04-003	1					1			1		1	
	NSS-04-004	1					1			1		1	
	NSS-04-005	1					1			1		1	
	NSS-04-006	1					1			1		1	
Sewage Lagoon (SWMU-14)	Sediment (c) Sample												
	NSD-14-001												
	NSD-14-002												
	Groundwater												
	M-134-90	2	2	2						2		2	
	B-1	2	2	2						2		2	
	N-185-90	2	2	2						2		2	
	N-117-88	2	2	2						2		2	
	A-2	2	2	2						2		2	
	Surface Water	1	1							1		1	
	SW-14-001	1	1							1		1	
	SW-14-002	1	1							1		1	
AED Demilitarization	NSS-19-001	1		1			1			1		1	
Test Facility	NSS-19-002	1		1			1			1		1	
(SWMU-19)	NSS-19-003	1		1			1			1		1	
Two samples will	NSS-19-004	1		1			1			1		1	
also be selected for	NSS-19-005	1		1			1			1		1	
reactivity analysis.	NSS-19-006	1		1			1			1		1	

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	Analyses Needed: VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring SS = Surface Soil EP = Excavation Pit SW = Surface Water	SD = Sediment AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
AED Demilitarization	NSS-19-007	1		1									
Test Facility	NSS-19-008	1		1			1			1		1	
(SWMU-19)	NSS-19-009	1		1			1			1		1	
(continued)	NSS-19-010	1		1			1			1		1	
	NSS-19-011	1		1			1			1		1	
	NSS-19-012	1		1			1			1		1	
							1			1		1	
AED Deactivation	Surface Soil	1											
Furnace Site	NSS-20-001	1								1			
(SWMU-20)	NSS-20-002	1								1			
Two samples will	NSS-20-003	1								1			
also be selected for	NSS-20-004	1								1			
TCLP metals	NSS-20-005	1								1			
analysis.	NSS-20-006	1								1			
	NSS-20-007	1								1			
	NSS-20-008	1								1			
	NSS-20-009	1								1			
	NSS-20-010	1								1			
	NSS-20-011	1								1			
	NSS-20-012	1								1			
	NSS-20-013	1								1			
	NSS-20-014	1								1			
	NSS-20-015	1								1			
	NSS-20-016	1								1			
	NSS-20-017	1								1			
	NSS-20-018	1								1			
	NSS-20-019	1								1			
	NSS-20-020	1								1			
										1			

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	Analyses Needed VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated		2-120mls, filled	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 4-oz
EP = Excavation Pit	Carbon		completely	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth
SW = Surface Water			4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark
AED Deactivation	Surface Soil												
Furnace Building	NSS-21-001			1				1		1			
(SWMU-21)	NSS-21-002			1				1		1			
	NSS-21-003			1				1		1			
	NSS-21-004			1				1		1			
	NSS-21-005			1				1		1			
	NSS-21-006			1				1		1			
	NSS-21-007			1				1		1			
	NSS-21-008			1				1		1			
	NSS-21-009			1				1		1			
	NSS-21-010			1				1		1			
	NSS-21-011			1				1		1			
	NSS-21-012			1				1		1			
	NSS-21-013			1				1		1			
	NSS-21-014			1				1		1			
	NSS-21-015			1				1		1			
	NSS-21-016			1				1		1			
DRMO Storage Yard	Shallow												
(SWMU-26)	Soil Boring												
	NSB-26-001	1	1	1				1					
	NSB-26-002	1	1	1				1					
	NSB-26-003	1	1	1				1					
	NSB-26-004	1	1	1				1					
	NSB-26-005	1	1	1				1					
	NSB-26-006	1	1	1				1					
	NSB-26-007	1	1	1				1					
	NSB-26-008	1	1	1				1					
	NSB-26-009	1	1	1				1					
	NSB-26-010	1	1	1				1					

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Analyses Needed Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
EP = Excavation Pit													
SW = Surface Water													
DRMO Storage Yard	NSB-26-011	1	1	1				1					
(SWMU-26)	NSB-26-012	1	1	1				1					
(continued)	NSB-26-013	1	1	1				1					
	NSB-26-014	1	1	1				1					
	NSB-26-015	1	1	1				1					
	Surface Soil												
	NSS-26-001	1	1	1				1					
	NSS-26-002	1	1	1				1					
	NSS-26-003	1	1	1				1					
	NSS-26-004	1	1	1				1					
	NSS-26-005	1	1	1				1					
	NSS-26-006	1	1	1				1					
	NSS-26-007	1	1	1				1					
	NSS-26-008	1	1	1				1					
	NSS-26-009	1	1	1				1					
	NSS-26-010	1	1	1				1					
	NSS-26-011	1	1	1				1					
	NSS-26-012	1	1	1				1					
	NSS-26-013	1	1	1				1					
	NSS-26-014	1	1	1				1					
	NSS-26-015	1	1	1				1					
	NSS-26-016	1	1	1				1					
	NSS-26-017	1	1	1				1					
	NSS-26-018	1	1	1				1					
	NSS-26-019	1	1	1				1					
	NSS-26-020	1	1	1				1					
	NSS-26-021	1	1	1				1					
	NSS-26-022	1	1	1				1					
	NSS-26-023	1	1	1				1					

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
							Analyses Needed						
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
EP = Excavation Pit													
SW = Surface Water													
DRMO Storage Yard	NSS-26-024	1	1	1				1					
(SWMU-26)	NSS-26-025	1	1	1				1					
(continued)	NSS-26-026	1	1	1				1					
	NSS-26-027	1	1	1				1					
	NSS-26-028	1	1	1				1					
	NSS-26-029	1	1	1				1					
	NSS-26-030	1	1	1				1					
	NSS-26-014	1	1	1				1					
Drum Storage Area	Shallow Soil												
(SWMU-29)	Boring												
	NSB-29-001	2	1	1	2				1	2			
	NSB-29-002	2	1	1	2				1	2			
	NSB-29-003	2	1	1	2				1	2			
	NSB-29-004	2	1	1	2				1	2			
	NSB-29-005	2	1	1	2				1	2			
	NSB-29-006	2	1	1	2				1	2			
	NSB-29-007	2	1	1	2				1	2			
	NSB-29-008	2	1	1	2				1	2			
	NSB-29-009	2	1	1	2				1	2			
	NSB-29-010	2	1	1	2				1	2			
	NSB-29-011	2	1	1	2				1	2			
	NSB-29-012	2	1	1	2				1	2			
	NSB-29-013	2	1	1	2				1	2			
	NSB-29-014	2	1	1	2				1	2			
	NSB-29-015	2	1	1	2				1	2			
	NSB-29-016	2	1	1	2				1	2			
	NSB-29-017	2	1	1	2				1	2			
	NSB-29-018	2	1	1	2				1	2			
	NSB-29-019	2	1	1	2				1	2			

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Analyses Needed Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated Carbon		2-120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
EP = Excavation Pit													
SW = Surface Water													
Drum Storage Area	NSB-29-020	2	1	1	2				1	2			
(SWMU-29)	NSB-29-021	2	1	1	2				1	2			
(continued)	NSB-29-022	2	1	1	2				1	2			
	NSB-29-023	2	1	1	2				1	2			
	NSB-29-024	2	1	1	2				1	2			
	NSB-29-025	2	1	1	2				1	2			
	NSB-29-026	2	1	1	2				1	2			
	NSB-29-027	2	1	1	2				1	2			
	NSB-29-028	2	1	1	2				1	2			
	NSB-29-029	2	1	1	2				1	2			
	NSB-29-030	2	1	1	2				1	2			
	NSB-29-031	2	1	1	2				1	2			
	NSB-29-032	2	1	1	2				1	2			
	NSB-29-033	2	1	1	2				1	2			
	NSB-29-034	2	1	1	2				1	2			
	NSB-29-035	2	1	1	2				1	2			
	NSB-29-036	2	1	1	2				1	2			
	NSB-29-037	2	1	1	2				1	2			
Pesticide Handling	Surface Soil												
and Storage Area	NSS-34-001	1			1	1				1			
(SWMU-34)	NSS-34-002	1			1	1				1			
	NSS-34-003	1			1	1				1			
	NSS-34-004	1			1	1				1			
	NSS-34-005	1			1	1				1			
Contaminated Waste	Surface Soil												
Processing Plant	NSS-37-001	1		1				1		1			
(SWMU-37)	NSS-37-002	1		1				1		1			
	NSS-37-003	1		1				1		1			

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Analyses Needed Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated		2 - 120mls, filled	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 4-oz
EP = Excavation Pit	Carbon		completely	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth
SW = Surface Water			4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark
Contaminated Waste	NSS-37-004	1		1				1		1			
Processing Plant	NSS-37-005	1		1				1		1			
(SWMU-37)	NSS-37-006	1		1				1		1			
(continued)	NSS-37-007	1		1				1		1			
	NSS-37-008	1		1				1		1			
	NSS-37-009	1		1				1		1			
	NSS-37-010	1		1				1		1			
	NSS-37-011	1		1				1		1			
	NSS-37-012	1		1				1		1			
	NSS-37-013	1		1				1		1			
	NSS-37-014	1		1				1		1			
	NSS-37-015	1		1				1		1			
	NSS-37-016	1		1				1		1			
	NSS-37-017	1		1				1		1			
	NSS-37-018	1		1				1		1			
	NSS-37-019	1		1				1		1			
	NSS-37-020	1		1				1		1			
Industrial Treatment	Surface Soil												
Plant (SWMU-38)	NSS-38-001	1	1	1						1			
	NSS-38-002	1	1	1						1			
	NSS-38-003	1	1	1						1			
	NSS-38-004	1	1	1						1			
Carbon TCLP will	NAC-38-001	1	1	1						1			
Also be analyzed for													
marked analysis.													

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

			Analyses Needed										
SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated		2 - 120mls, filled	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 4-oz
EP = Excavation Pit	Carbon		completely	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth
SW = Surface Water			4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark
Bomb Washout	Shallow Soil												
Building (SWMU-42)	Boring												
Select 3 soil boring	NSB-42-001	2					2			2			
samples for TCLP	NSB-42-002	2					2			2			
for marked analyses.	NSB-42-003	2					2			2			
	NSB-42-004	2					2			2			
	NSB-42-005	2					2			2			
	NSB-42-006	2					2			2			
	NSB-42-007	2					2			2			
	NSB-42-008	2					2			2			
	NSB-42-009	2					2			2			
	NSB-42-010	2					2			2			
	NSB-42-011	2					2			2			
	NSB-42-012	2					2			2			
	NSB-42-013	2					2			2			
	NSB-42-014	2					2			2			
Select 1 surface soil	Surface Sample												
for TCLP for marked	NSS-42-001	2					2			2			
analysis.	NSS-42-002	2					2			2			
Bomb Washout	NSS-42-003	2					2			2			
Building (SWMU-42)	NSS-42-004	2					2			2			
(continued)	NSS-42-005	2					2			2			
	NSS-42-006	2					2			2			
Stormwater	Shallow												
Discharge Area	Soil Boring												
(SWMU-45)	NSB-45-001	7	7	7	7		7			7			

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	Analyses Needed: VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated Carbon		2 -120mls, filled completely 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 8-oz wide mouth 4C in dark	1 4-oz mouth 4C in dark
EP = Excavation Pit													
SW = Surface Water													
Stormwater	Sediment												
Discharge Area	NSD-45-001	1	1	1	1		1			1			
(SWMU-45)	NSD-45-002	1	1	1	1		1			1			
(continued)	NSD-45-003	1	1	1	1		1			1			
	NSD-45-004	1	1	1	1		1			1			
	Surface Water												
	NSD-45-005	1	1	1	1		1			1			
	NSW-45-001	1	1	1	1		1			1			
	NSW-45-001	1	1	1	1		1			1			
	NSW-45-004	1	1	1	1		1			1			
	NSW-45-005	1	1	1	1		1			1			
Used Oil Dumpsters	NSB-46-001	2							2				
(SWMU-46)	NSB-46-002	2							2				
	NSB-46-003	2							2				
	NSB-46-004	2							2				
	NSB-46-005	2							2				
	NSB-46-006	2							2				
	NSB-46-007	2							2				
	NSB-46-008	2							2				
	NSB-46-009	2							2				
	NSB-46-010	2							2				
	NSB-46-011	2							2				
	NSB-46-012	2							2				
	NSB-46-013	2							2				
	NSB-46-014	2							2				
	NSB-46-015	2							2				
	NSB-46-016	2							2				
	NSB-46-017	2							2				

SUMMARY OF SAMPLES SCHEDULED FOR THE N TEAD RFI

SWMU No./ Site Name	JMM Field ID	Number of Samples	VOCs EPA 8240	SVOCs EPA 8270	Pesticides EPA 8080	Herbicides EPA 8140	Explosives USATHAMA	Analyses Needed Dioxins/Furans EPA 8280	TRPH EPA 418.1	Metals EPA 6010/7471	Cyanide EPA 9010	Anions EPA 300.0	pH EPA 9045
SB = Soil Boring	SD = Sediment												
SS = Surface Soil	AC = Activated		2 - 120mls, filled	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 8-oz wide	1 4-oz
EP = Excavation Pit	Carbon		completely	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth	mouth
SW = Surface Water			4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark	4C in dark
Used Oil Dumpsters	NSB-46-018	2							2				
(SWMU-46)	NSB-46-019	2							2				
(continued)	NSB-46-020	2							2				
	NSB-46-021	2							2				
	NSB-46-022	2							2				
	NSB-46-023	2							2				
	NSB-46-028	2							2				
Boiler Blowdown	NSD-47-001	2	2	2					2	2			
Water (SUMP)	NSD-47-002	2	2	2					2	2			
(SWMU-47)	NSD-47-003	2	2	2					2	2			
	NS2-47-001	2	2	2					2	2			
	NSW-47-002	2	2	2					2	2			
	NSW-47-003	2	2	2					2	2			
Background	NSB-BK-001	2											
(estimated)	NSB-BK-002	2								2		2	2
	NSB-BK-003	2								2		2	2
	NSB-BK-004	2								2		2	2
	NSB-BK-005	2								2		2	2
	NSB-BK-025	2								2		2	2

(a) A total of eight samples from the excavation pits and a total of five samples from the deep soil borings will be selected for reactivity analysis.

(b) A total of eight samples from the excavation pits and a total of three samples from the deep soil borings will be selected for reactivity analysis.

(c) TCLP analysis will be conducted in addition to regular analysis.

APPENDIX D

EXPLOSIVE SCREENING FIELD METHOD

COLORIMETRIC FIELD METHOD DESCRIPTION FOR NITROAROMATIC COMPOUNDS IN SOILS AND SEDIMENTS

Reagents:

- Denatured ethanol
- 1,3-denatured diphenylacetone and tetraethylammonium hydroxide

Equipment:

- UV/VIS Spectrophotometer
- Vacuum for filtering
- Analytical balance
- Disposable 1-cm pathlength cuvettes for transmitting at 500 nm
- 50-ml centrifuge tubes with screw top Teflon-lined caps and stand
- Disposable pipettes
- 5-ml Iver-Lok syringes
- Polytetrafluoroethylene Gelman Arodisc 0.45 - m filters

Sample Preparation:

- measure absorbance at 500 nanometers of one clean disposable cuvette.
- Weight 10 grams of soil sample into a 50-ml centrifuge tube.
- Add 20 ml of ethanol to the 50-ml centrifuge tube, gently invert the tube three to five times, allow solids to settle.
- Using the 5-ml syringe, withdraw 3 ml of the ethanol, filter under vacuum through a Gelman filter - collect 2 ml of the filtrate in the cuvette.

Measurement:

- Measure the absorbance of the ethanol filtrate at 500 nanometers.
- If the absorbance is less than 0.6 absorbance units, the colorimetric reagent may be added directly to the ethanol filtrate. If the absorbance is greater than or equal to 0.6 absorbance units, the ethanol filtrate should be diluted 1 to 10 with ethanol.
- Add 0.5 ml diphenylacetone/tetraethylammonium hydroxide to the 2 ml ethanol filtrate (or diluted ethanol filtrate). Color development should occur within 5 minutes.
- Measure absorbance at 500 nanometers.

Calibrate Standards:

- Spike 2 mls of ethanol with 0, 10, 20, 40, 100, and 200 mg of 246TNT. Measure absorbance of each spike, plot absorbance versus TNT concentration in mg/kg.

Calculations:

- For measured samples,

$$\text{absorbance of sample} = \text{absorbance with colorimetric extract} - \text{absorbance without colorimetric extract}$$

- From calibration curve, determine TNT concentration for the sample using the absorbance of the sample.

Detection Limits:

- Undiluted samples: 10 mg/kg
- Samples diluted 1 to 10: 10 mg/kg

APPENDIX E

ANALYTE AND METHOD LISTS

METHOD AND ANALYTE LIST

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
Metals in Soil					
JB01	HG	MERCURY	0.05	1	1.020
JD15	SE	SELENIUM	0.25	10	0.757
JD19	AS	ARSENIC	0.25	10	0.842
JS11	AG	SILVER	2.5	50	0.965
JS11	AL	ALUMINUM	14.1	50000	1.000
JS11	BA	BARIUM	29.6	200	0.629
JS11	BE	BERYLLIUM	1.86	20	0.739
JS11	CA	CALCIUM	59	5000	0.615
JS11	CD	CADMIUM	3.05	20	0.826
JS11	CO	COBALT	15	5000	0.608
JS11	CR	CHROMIUM	12.7	5000	0.613
JS11	CU	COPPER	58.6	5000	0.675
JS11	FE	IRON	50	5000	1.040
JS11	K	POTASSIUM	37.5	5000	0.733
JS11	MG	MAGNESIUM	50	5000	0.660
JS11	MN	MANGANESE	0.275	5000	0.642
JS11	NA	SODIUM	150	5000	0.703
JS11	NI	NICKEL	12.6	5000	0.593
JS11	PB	LEAD	6.62	500	1.05
JS11	SB	ANTIMONY	3.8	5000	0.581
JS11	TL	THALLIUM	31.3	5000	0.580
JS11	V	VANADIUM	13	5000	0.65
JS11	ZN	ZINC	30.2	5000	0.573
Anions in Soil					
KF10	NIT	NITRITE, NITRATE (NON-SPECIFIC)	0.6	12	1.08
KF14	TPO4	PHOSPHOROUS	7.49	100	0.953
KT05	CL	CHLORIDE	6.05	204	0.994
KT05	SO4	SULFATE	90.4	512	0.904
Cyanide in Soil					
KY01	CYN	CYANIDE	0.92	10	0.924
Organochlorine Pesticides in Soil					
LH10	ABHC	BHC,A	0.00907	0.027	0.919
LH10	AENSLF	ENDOSULFAN,A	0.00602	0.0244	1.03
LH10	ALDRN	ALDRIN,SED	0.00729	0.0257	0.988
LH10	BBHC	BHC,B,SED	0.00257	0.0254	0.975
LH10	BENSLF	ENDOSULFAN,B	0.00663	0.0244	1.1
LH10	CLDAN	CHLORDANE,SED	0.0177	0.197	0.839
LH10	DBHC	BHC,D,SED	0.00555	0.0252	1.28

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
LH10	DLDRN	DIELDRIN	0.00629	0.0254	1.04
LH10	ENDRN	ENDRIN	0.00657	0.0252	1.09
LH10	ENDRNA	ENDRIN ALDEHYDE	0.024	0.0302	0.871
LH10	ESFSO4	ENDOSULFAN SULFATE	0.000763	0.0286	1.06
LH10	HPCL	HEPTACHLOR	0.00618	0.0262	1.04
LH10	HPCLE	HEPTACHLOR EPOXIDE	0.0062	0.026	1.04
LH10	ISODR	ISODRIN	0.00461	0.0412	0.941
LH10	LIN	BHC,G	0.00638	0.0262	1.03
LH10	MEXCLR	METHOXYCHLOR	0.0711	0.249	1.2
LH10	PPDDD	DDD,PP'	0.00826	0.0246	1.11
LH10	PPDDE	DDE,PP'	0.00765	0.0286	1.06
LH10	PPDDT	DDT,PP'	0.00707	0.0281	1.01
LH10	TXPHEN	TOXAPHENE	0.444	1.12	1.35
Herdicides in Soil					
LH11	24D	2,4-D	17.7	202	1.08
LH11	245TP	SILVEX	8.5	109	0.907
Semivolatiles in Soil					
LM18	124TCB	1,2,4-TRICHLOROBENZENE	0.04	13	0.801
LM18	12DCLB	1,2-DICHLOROBENZENE	0.11	13	0.734
LM18	12DPH	1,2-DIPHENYL HYDRAZINE	0.14		
LM18	13DCLB	1,3-DICHLOROBENZENE	0.13	13	0.724
LM18	14DCLB	1,4-DICHLOROBENZENE	0.098	13	0.715
LM18	245TCP	2,4,5-TRICHLOROPHENOL	0.1	13	0.897
LM18	246TBP	2,4,6-TRIBROMOPHENOL	0.38	13	0.91
LM18	246TCP	2,4,6-TRICHLOROPHENOL	0.17	13	0.948
LM18	24DCLP	2,4-DICHLOROPHENOL	0.18	13	0.909
LM18	24DMPN	2,4-DIMETHYLPHENOL	0.69	1.3	0.917
LM18	24DNP	2,4-DINITROPHENOL	2.1	6.7	0.816
LM18	24DNT	2,4-DINITROTOLUENE	0.14	13	0.936
LM18	26DNT	2,6-DINITROTOLUENE	0.085	13	0.954
LM18	2CLP	2-CHLOROPHENOL	0.06	13	0.745
LM18	2CNAP	2-CHLORONAPHTHALENE	0.036	13	0.847
LM18	2FBP	FLUOROBIPHENYL	0.021	6.7	0.903
LM18	2FP	2-FLUOROPHENOL	0.12	13	0.744
LM18	2MNAP	2-METHYLNAPHTHLENE	0.049	6.7	0.828
LM18	2MP	2-METHYLPHENOL	0.029	1.3	0.490
LM18	2NANIL	2-NITROANILINE	0.062	13	0.865
LM18	2NP	2-NITROPHENOL	0.14	13	0.915
LM18	33DCBD	3,3-DICHLOROBENZIDINE	6.3	13	0.633

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
LM18	3NANIL	3-NITROANILINE	0.45	13	0.909
LM18	46DN2C	2-METHYL-4,6-DINITROPHENOL	0.55	13	1.060
LM18	4BRPPE	4-BROMOPHENYLPHENYL ETHER	0.033	6.7	0.921
LM18	4CANIL	4-CHLOROANALINE	0.81	3.3	0.517
LM18	4CL3C	3-METHYL-4-CHLOROPHENOL	0.095	13	0.894
LM18	4CLPPE	4-CHLOROPHENYLPHENYL ETHER	0.033	13	0.826
LM18	4MP	4-METHYLPHENOL	0.24	1.3	0.439
LM18	4NANIL	4-NITROANALINE	0.41	13	0.739
LM18	4NP	4-NITROPHENOL	1.4	33	0.921
LM18	ABHC	BHC, A	0.27		
LM18	AENSLF	ENDOSULFAN A	0.62		
LM18	ALDRN	ALDRIN	0.33		
LM18	ANAPNE	ACENAPHTHENE	0.036	13	0.826
LM18	ANAPYL	ACENAPHTHYLENE	0.033	6.7	0.881
LM18	ANTRC	ANTHRACENE	0.033	13	0.870
LM18	B2CEXM	BIS(2-CHLOROETHOXY) METHANE	0.059	13	0.863
LM18	B2CIPE	BIS(2-CHLOROISOPROPYL) ETHER	0.2	13	0.819
LM18	B2CLEE	BIS(2-CHLOROETHYL) ETHER	0.033	6.7	0.802
LM18	B2EHP	BIS(2-EHTYLHEXYL) PHTHALATE	0.62	13	0.974
LM18	BAANTR	BENZO [A] ANTHRACENE	0.17	13	1.060
LM18	BAPYR	BENZO [A] PYRENE	0.25	13	0.840
LM18	BBFANT	BENZO [B] FLUORANTHENE	0.21	3.3	0.785
LM18	BBHC	BHC, B	0.27		
LM18	BBZP	BUTYLBENZYL PHTHALATE	0.17	6.7	0.963
LM18	BENSLF	ENDOSULFAN B	0.62		
LM18	BENZID	BENZIDINE	0.85		
LM18	BENZOA	BENZOIC ACID			
LM18	BGHIPY	BENZO [G,H,I] PERYLENE	0.25	3.3	1.020
LM18	BKFANT	BENZO [K] FLUORANTHENE	0.066	0.67	0.964
LM18	BZALC	BENZYL ALCOHOL	0.19	1	0.963
LM18	CHRY	CHRYSENE	0.12	36.7	0.816
LM18	CL6BZ	HEXACHLOROBENZENE	0.033	6.7	0.907
LM18	CL6CP	HEXACHLOROCYCLOPENTADIENE	6.2	13	0.131
LM18	CL6ET	HEXACHLOROETHANE	0.15	13	0.716
LM18	CLDANA	CHLORDANE, ALPHA	0.33		
LM18	CLDANG	CHLORDANE, GAMMA	0.33		
LM18	DBAHA	DIBENZ [A,H] ANTHRACENE	0.21	13	0.999
LM18	DBHC	BHC, D	0.27		
LM18	DBZFUR	DIBENZOFURAN	0.035	6.7	0.901
LM18	DEP	DIETHYL PHTHALATE	0.24	6.7	0.927
LM18	DLDRN	DDIELDRIN	0.31		

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
LM18	DMP	DIMETHYL PHTHALATE	0.17	13	0.890
LM18	DNBP	DI-N-BUTYL PHTHALATE	0.061	3.3	0.935
LM18	DNOP	DI-N-OCTYL PHTHALATE	0.19	6.7	0.712
LM18	ENDRIN	ENDRIN	0.45		
LM18	ENDRNA	ENDRIN ALDEHYDE	0.53		
LM18	ESFSO4	ENDOSULFAN SULFATE	0.62		
LM18	FANT	FLUORANTHENE	0.068	13	0.863
LM18	FLRENE	FLUORENE	0.033	13	0.856
LM18	GBHC	BHC, G (LINDANE)	0.27		
LM18	HCBD	HEXACHLOROBUTADIENE	0.23	13	0.747
LM18	HPCL	HEPTACHLOR	0.13		
LM18	HPCLE	HEPTACHLOR EPOXIDE	0.33		
LM18	ICDPYR	INDENO [1,2,3-CD] PYRENE	0.29	13	0.948
LM18	ISOPHR	ISOPHORONE	0.033	13	0.833
LM18	KEND	ENDRIN KETONE	0.53		
LM18	MEXCLR	METHOXYCHLOR	0.33		
LM18	NAP	NAPHTHALENE	0.037	3.3	0.858
LM18	NB	NITROBENZENE	0.045	13	0.840
LM18	NBD5	NITROBENZENE-D(5)	0.025	6.7	0.858
LM18	NNDMEA	N-NITROSODIMETHYLAMINE	0.14		
LM18	NNDNPA	N-NITROSO, DI-N-PROPYLAMINE	0.2	13	0.849
LM18	NNDPA	N-NITROSODIPHENYLAMINE	0.19	13	0.848
LM18	PCB016	PCB-1016	1.4		
LM18	PCB221	PCB-1221	1.4		
LM18	PCB232	PCB-1232	1.4		
LM18	PCB242	PCB-1242	1.4		
LM18	PCB248	PCB-1248	2		
LM18	PCB254	PCB-1254	2.3		
LM18	PCB260	PCB-1260	2.6		
LM18	PCP	PENTACHLOROPHENOL	1.3	6.7	0.790
LM18	PHANTR	PHENANTHRENE	0.033	13	0.969
LM18	PHEND6	PHENOL-D(6)	0.23	13	0.824
LM18	PHENOL	PHENOL	0.11	3.3	0.811
LM18	PPDDD	DDD, PP	0.3		
LM18	PPDDE	DDE, PP	0.31		
LM18	PPDDT	DDT, PP	0.31		
LM18	PYR	PYRENE	0.033	3.3	0.845
LM18	TRPD14	TERPHENYL-D(14)	0.34	6.7	1.07
LM18	TXPHEN	TOXAPHENE	2.6		

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
Volatile Organics in Soil					
LM19	111TCE	1,1,1-TRICHLOROETHANE	0.0044	0.2	1.200
LM19	112TCE	1,1,2-TRICHLOROETHANE	0.0054	0.2	1.100
LM19	11DCE	1,1-DICHLOROETHENE	0.0039	0.1	1.070
LM19	11DCLE	1,1-DICHLOROETHANE	0.0023	0.2	1.030
LM19	12DCD4	1,2-DICHLOROETHENE-D(4)	0.0032	0.2	0.995
LM19	12DCE	1,2-DICHLOROETHENE	0.003	0.1	0.986
LM19	12DCLE	1,2-DICHLOROETHANE	0.0017	0.2	1.020
LM19	12DCLP	1,2-DICHLOROPROPANE	0.0029	0.2	1.100
LM19	2CLEVE	2-CHLOROETHYLVINYL ETHER			
LM19	4BFB	4-BROMOFLUOROBENZENE	0.0029	0.2	0.924
LM19	ACET	ACETONE	0.017	0.1	0.970
LM19	ACROLN	ACROLEIN			
LM19	ACRYLO	ACRYLONITRILE			
LM19	BRDCLM	BROMODICHLOROMETHANE	0.0029	0.2	1.180
LM19	C13DCP	CIS-1,3-DICHLOROPROPENE	0.0032	0.248	1.130
LM19	C2AVE	VINYL ACETATE	0.0032	0.1	1.370
LM19	C2H3CL	VINYL CHLORIDE	0.0062	0.2	1.090
LM19	C2H5CL	CHLOROETHANE	0.012	0.2	1.050
LM19	C6H6	BENZENE	0.0015	0.2	1.020
LM19	CCL3F	TRICHLOROFLUOROMETHANE	0.0059	0.1	1.170
LM19	CCL4	CARBON TETRACHLORIDE	0.007	0.2	1.270
LM19	CH2CL2	METHYLENE CHLORIDE	0.012	0.2	0.988
LM19	CH3BR	BROMOMETHANE	0.0057	0.2	0.891
LM19	CH3CL	CHLOROMETHANE	0.0088	0.1	0.882
LM19	CHBR3	BROMOFORM	0.0069	0.2	1.330
LM19	CHCL3	CHLOROFORM	0.00087	0.2	1.030
LM19	CL2BC	DICHLOROBENZENE (TOTAL)			
LM19	CLC6H5	CHLOROBENZENE	0.00086	0.2	1.070
LM19	CS2	CARBON DISULFIDE	0.0044	0.1	0.993
LM19	DBRCLM	DIBROMOCHLOROMETHANE	0.0031	0.2	1.223
LM19	ETC6H5	ETHYLBENZENE	0.0017	0.2	1.030
LM19	MEC6D8	TOLUENE-D(8)	0.0017	0.2	0.999
LM19	MEC6H5	TOLUENE	0.00078	0.2	1.020
LM19	MEK	METHYL ETHYL KETONE	0.07	0.2	1.140
LM19	MIBK	METHYL ISOBUTYL KETONE	0.027	0.1	1.300
LM19	MNBK	METHYL-N-BUTYL KETONE	0.032	0.1	1.240
LM19	STYR	STYRENE	0.0026	0.2	1.030
LM19	T13DCP	TRANS-1,3-DICHLOROPROPENE	0.0028	0.152	1.150
LM19	TCLEA	1,1,2,2-TETRACHLOROETHANE	0.0024	0.2	1.130
LM19	TCLEE	TETRACHLOROETHENE	0.00081	0.2	1.030

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
LM19	TRCLE	TRICHLOROETHENE	0.0028	0.2	1.160
LM19	XYLEN	XYLENE	0.0015	0.2	1.010
Metals in Water					
SB01	HG	MERCURY	0.234	10	1.030
SD09	TL	THALLIUM	6.99	25	0.95
SD20	PB	LEAD	1.26	100	0.922
SD21	SE	SELENIUM	3.02	100	0.939
SD22	AS	ARSENIC	2.54	100	0.938
SS10	AG	SILVER	4.6	2500	0.989
SS10	AL	ALUMINUM	141	45000	0.891
SS10	BA	BARIUM	5	10000	1.080
SS10	BE	BERYLLIUM	5	1000	0.893
SS10	CA	CALCIUM	500	20000	0.974
SS10	CD	CADMIUM	4	5000	1.000
SS10	CO	COBALT	25	10000	0.879
SS10	CR	CHROMIUM	6	50000	1.01
SS10	CU	COPPER	8.1	500000	0.985
SS10	FE	IRON	42.7	20000	0.907
SS10	K	POTASSIUM	375	50000	0.881
SS10	MG	MAGNESIUM	500	2000	0.988
SS10	MN	MANGANESE	2.75	15000	0.934
SS10	NA	SODIUM	500	20000	0.954
SS10	NI	NICKEL	34.3	12500	0.860
SS10	SB	ANTIMONY	38	6000	0.844
SS10	V	VANADIUM	11	1000	0.958
SS10	ZN	ZINC	21.1	5000	0.949
Cyanide in Water					
TF18	CYN	CYANIDE	2.5	50	1
Anions in Water					
TF22	NIT	NITRITE	10	200	0.999
TF27	PO4	TOTAL PHOSPHATES	13.3	500	1.01
TT10	CL	CHLORIDE	2120	30000	0.911
TT10	SO4	SULFATE	10000	600000	1
Semivolatiles in Water					
UM18	124TCB	1,2,4-TRICHLOROBENZENE	1.8	50	0.824
UM18	12DCLB	1,2-DICHLOROBENZENE	1.7	50	0.856
UM18	12DPH	1,2-DIPHENYL HYDRAZINE	2		

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
UM18	13DCLB	1,3-DICHLOROBENZENE	1.7	200	0.790
UM18	14DCLB	1,4-DICHLOROBENZENE	1.7	200	0.786
UM18	245TCP	2,4,5-TRICHLOROPHENOL	5.2	200	1.060
UM18	246TBP	2,4,6-TBP	13	200	1.26
UM18	246TCP	2,4,6-TRICHLOROPHENOL	4.2	100	1.020
UM18	24DCLP	2,4-DICHLOROPHENOL	2.9	200	0.930
UM18	24DMPN	2,4-DIMETHYLPHENOL	5.8	100	0.938
UM18	24DNP	2,4-DINITROPHENOL	21	100	1.370
UM18	24DNT	2,4-DINITROTOLUENE	4.5	200	0.954
UM18	26DNT	2,6-DINITROTOLUENE	0.79	200	1.090
UM18	2CLP	2-CHLOROPHENOL	0.99	200	0.967
UM18	2CNAP	2-CHLORONAPHTHALENE	0.5	200	0.880
UM18	2FBP	2-FLUOROBIPHENYL	12	100	0.891
UM18	2FP	2-FLUOROPHENYL	17	200	0.657
UM18	2MNAP	2-METHYLNAPHTHLENE	1.7	50	0.919
UM18	2MP	2-METHYLPHENOL	3.9	200	0.967
UM18	2NANIL	2-NITROANILINE	4.3	100	0.958
UM18	2NP	2-NITROPHENOL	3.7	100	0.986
UM18	33DCBD	3,3-DICHLOROBENZIDINE	12	100	1.530
UM18	3NANIL	3-NITROANILINE	4.9	100	0.965
UM18	46DN2C	2-METHYL-4,6-DINITROPHENOL	17	100	1.220
UM18	4BRPPE	4-BROMOPHENYLPHENYL ETHER	4.2	100	0.902
UM18	4CANIL	4-CHLOROANALINE	7.3	100	0.872
UM18	4CL3C	3-METHYL-4-CHLOROPHENOL	4	200	0.989
UM18	4CLPPE	4-CHLOROPHENYLPHENYL ETHER	5.1	100	0.856
UM18	4MP	4-METHYLPHENOL	0.52	200	0.848
UM18	4NANIL	4-NITROANALINE	5.2	100	1.010
UM18	4NP	4-NITROPHENOL	12	100	0.662
UM18	ABHC	BHC, A	4		
UM18	AENSLF	ENDOSULFAN A	9.2		
UM18	ALDRN	ALDRIN	4.7		
UM18	ANAPNE	ACENAPHTHENE	1.7	50	0.946
UM18	ANAPYL	ACENAPHTHYLENE	0.5	50	0.966
UM18	ANTRC	ANTHRACENE	0.5	100	0.974
UM18	B2CEXM	BIS(2-CHLOROETHOXY) METHANE	1.5	50	0.928
UM18	B2CIPE	BIS(2-CHLOROISOPROPYL) ETHER	5.3	200	0.834
UM18	B2CLEE	BIS(2-CHLOROETHYL) ETHER	1.9	50	0.943
UM18	B2EHP	BIS(2-EHTYLHEXYL) PHTHALATE	4.8	100	1.100
UM18	BAANTR	BENZO [A] ANTHRACENE	1.6	100	0.996
UM18	BAPYR	BENZO [A] PYRENE	4.7	100	1.120
UM18	BBFANT	BENZO [B] FLUORANTHENE	5.4	50	1.050

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
UM18	BBHC	BHC, B	4		
UM18	BBZP	BUTYLBENZYL PHTHALATE	3.4	100	1.060
UM18	BENSLF	ENDOSULFAN B	9.2		
UM18	BENZID	BENZIDINE	10		
UM18	BENZOA	BENZOIC ACID	13	100	0.646
UM18	BGHIPY	BENZO [G,H,I] PERYLENE	6.1	50	1.300
UM18	BKFANT	BENZO [K] FLUORANTHENE	0.87	100	1.020
UM18	BZALC	BENZYL ALCOHOL	0.72	100	0.861
UM18	CHRY	CHRYSENE	2.4	100	0.967
UM18	CL6BZ	HEXACHLOROBENZENE	1.6	100	0.949
UM18	CL6CP	HEXACHLOROCYCLOPENTADIENE	8.6	100	0.707
UM18	CL6ET	HEXACHLOROETHANE	1.5	50	0.818
UM18	CLDANA	CHLORDANE, ALPHA	5.1		
UM18	CLDANG	CHLORDANE, GAMMA	5.1		
UM18	DBAHA	DIBENZ [A,H] ANTHRACENE	6.5	50	1.160
UM18	DBHC	BHC, D	4		
UM18	DBZFUR	DIBENZOFURAN	1.7	50	0.941
UM18	DEP	DIETHYL PHTHALATE	2	200	0.863
UM18	DLDRN	DDIELDRIN	4.7		
UM18	DMP	DIMETHYL PHTHALATE	1.5	100	0.807
UM18	DNBP	DI-N-BUTYL PHTHALATE	3.7	200	1.100
UM18	DNOP	DI-N-OCTYL PHTHALATE	15	100	1.280
UM18	ENDRIN	ENDRIN	7.6		
UM18	ENDRNA	ENDRIN ALDEHYDE	8		
UM18	ESFSO4	ENDOSULFAN SULFATE	9.2		
UM18	FANT	FLUORANTHENE	3.3	100	0.996
UM18	FLRENE	FLUORENE	3.7	50	0.960
UM18	GBHC	BHC, G (LINDANE)	4		
UM18	HCBD	HEXACHLOROBUTADIENE	3.4	100	0.731
UM18	HPCL	HEPTACHLOR	2		
UM18	HPCLE	HEPTACHLOR EPOXIDE	5		
UM18	ICDPYR	INDENO [1,2,3-CD] PYRENE	8.6	100	1.170
UM18	ISOPHR	ISOPHORONE	4.8	50	0.971
UM18	KEND	ENDRIN KETONE	8		
UM18	MEXCLR	METHOXYCHLOR	5.1		
UM18	NAP	NAPHTHALENE	0.5	20	1.150
UM18	NB	NITROBENZENE	0.5	50	0.887
UM18	NBD5	NITROBENZENE-D5	11	100	0.845
UM18	NNDMEA	N-NITROSODIMETHYLAMINE	2		
UM18	NNDNPA	N-NITROSO, DI-N-PROPYLAMINE	4.4	50	0.987
UM18	NNDPA	N-NITROSODIPHENYLAMINE	3	200	0.956

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
UM18	PCB016	PCB-1016	21		
UM18	PCB221	PCB-1221	21		
UM18	PCB232	PCB-1232	21		
UM18	PCB242	PCB-1242	30		
UM18	PCB248	PCB-1248	30		
UM18	PCB254	PCB-1254	36		
UM18	PCB260	PCB-1260	36		
UM18	PCP	PENTACHLOROPHENOL	18	100	1.260
UM18	PHANTR	PHENANTHRENE	0.5	100	1.000
UM18	PHEND6	PHENOL-D6	36	200	0.5
UM18	PHENOL	PHENOL	9.2	200	0.542
UM18	PPDDD	DDD, PP	4		
UM18	PPDDE	DDE, PP	4.7		
UM18	PPDDT	DDT, PP	9.2		
UM18	PYR	PYRENE	2.8	100	0.995
UM18	TRPD14	TERPHEYL-D14	14	100	0.878
UM18	TXPHEN	TOXAPHENE	36		
Volatile Organics in Water					
UM20	CCL4	CARBON TETRACHLORIDE	0.58	200	1.050
UM20	C2AVE	VINYL ACETATE	8.3	50	0.984
UM20	MIBK	METHYL ISOBUTYL KETONE	3	200	0.918
UM20	CH3CL	CHLOROMETHANE	3.2	200	0.952
UM20	MNBK	METHYL-N-BUTYL KETONE	3.6	200	0.917
UM20	CHCL3	CHLOROFORM	0.5	200	0.975
UM20	STYR	STYRENE	0.5	200	1.100
UM20	DBRCLM	DIBROMOCHLOROMETHANE	0.67	100	0.981
UM20	CL2BC	DICHLOROBENZENE (TOTAL)			
UM20	CH2CL2	METHYLENE CHLORIDE	2.3	100	1.060
UM20	ACROLN	ACROLEIN			
UM20	MEC6H5	TOLUENE	0.5	200	1.020
UM20	111TCE	1,1,1-TRICHLOROETHANE	0.5	200	1.010
UM20	TCLEA	1,1,2,2-TETRACHLOROETHANE	0.51	200	1.030
UM20	112TCE	1,1,2-TRICHLOROETHANE	1.2	200	0.943
UM20	TRCLE	TRICHLOROETHENE	0.5	200	1.050
UM20	11DCE	1,1-DICHLOROETHENE	0.5	200	1.060
UM20	ACET	ACETONE	13	200	1.020
UM20	11DCLE	1,1-DICHLOROETHANE	0.68	200	0.881
UM20	12DCE	1,2-DICHLOROETHENE (TOTAL)	0.5	200	1.03
UM20	12DCLE	1,2-DICHLOROETHANE	0.5	50	0.995
UM20	ACRYLO	ACRYLONITRILE			

METHOD AND ANALYTE LIST
(CONTINUED)

METHOD #	TEST NAME	ANALYTE NAME	CRL	UCR	SLOPE
UM20	12DCLP	1,2-DICHLOROPROPANE	0.5	200	1.020
UM20	CLC6H5	CHLOROBENZENE	0.5	200	1.040
UM20	2CLEVE	2-CHLOROETHYLVINYL ETHER	0.71	200	1.01
UM20	ETC6H5	ETHYLBENZENE	0.5	200	1.050
UM20	BRDCLM	BROMODICHLOROMETHANE	0.59	200	1.020
UM20	TCLEE	TETRACHLOROETHENE	1.6	200	0.984
UM20	C13DCP	CIS-1,3-DICHLOROPROPENE	0.58	230	1.020
UM20	CS2	CARBON DISULFIDE	0.5	200	0.882
UM20	C2H3CL	VINYL CHLORIDE	2.6	200	0.964
UM20	CHBR3	BROMOFORM	2.6	200	1.050
UM20	C2H5CL	CHLOROETHANE	1.9	200	0.980
UM20	T13DCP	TRANS-1,3-DICHLOROPROPENE	0.7	280	0.964
UM20	C6H6	BENZENE	0.5	200	1.010
UM20	MEK	METHYL ETHYL KETONE	6.4	200	0.992
UM20	XYLEN	XYLENE	0.84	200	1.060
UM20	CH3BR	BROMOMETHANE	5.8	100	1.010
UM20	CCL3F	TRICHLOROFLUOROMETHANE	1.4	50	0.998
Explosives in Water					
UW32	13DNB	1,3-DINITROBENZENE	0.611	55	0.949
UW32	TETRYL	NITRAMINE	1.56	107.5	0.968
UW32	HMX	CYCLOTETRAMETHYLENE TETRANITI	1.21	120.8	1.002
UW32	246TNT	2,4,6-TRINITROTOLUENE	0.635	112	0.911
UW32	135TNB	1,3,5-TRINITROBENZENE	0.449	59.2	0.993
UW32	26DNT	2,6-DINITROTOLUENE	0.0738	24.4	0.982
UW32	NB	NITROBENZENE	0.645	129	0.92
UW32	24DNT	2,4-DINITROTOLUENE	0.0637	21.2	0.929
UW32	RDX	CYCLONITE	1.17	116.8	0.951
UW32	4A26DT	4-AMINO-2,6-DINITROTOLUENE	1.57	20.8	1.121
UW32	2A46DT	2-AMINO-4,6-DINITROTOLUENE	0.158	22	0.974
UW32	2NT	2-NITROTOLUENE	0.406	122.6	0.936
UW32	3NT	3-NITROTOLUENE	1.4	116.8	0.935
UW32	4NT	4-NITROTOLUENE	1.11	120.4	0.914

CRL = Contract Required Limit
UCR = Upper Control Range

APPENDIX F

FIELD CHECKLISTS

FIELD CHECKLIST

Signature of Auditor ______________ Date of Audit ____________

Project Coordinator ______________ Project No. ____________

Project Location ____

Type of Investigation ____________________________________
(Authority, Agency)

Briefing with Project Coordinator

Yes _ No _ N/A _

1. Was a project plan prepared? If yes, what items are addressed in the plan?

____
____
____

Yes _ No _ N/A _

2. Were additional instructions given to project participants (i.e., changes in project plan)? If yes, describe these changes.

____
____
____

Yes _ No _ N/A _

3. Is there a written list of sampling locations and descriptions? If yes, describe where documents are.

____
____
____

Yes _ No _ N/A _

4. Is there a map of sampling locations? If yes, where is the map?

____
____
____

Yes _ No _ N/A _

5. Do the investigators follow a system of accountable documents? If yes, what documents are accountable?

____
____
____

Yes _ No _ N/A _

6. Is there a list of accountable field documents checked out to the project coordinator? If yes, who checked them out and where is this documented?

____
____
____

Yes _ No _ N/A _

7. Is the transfer of field documents (sample tags, chain-of-custody records, logbooks, etc.) from the project coordinator to the field participants documented? If yes, where is the transfer documented?

____
____
____

Yes _ No _ N/A _

8. Have the team members received the adequate training for their position? Documented?

____
____
____

Yes _ No _ N/A _

9. Have the team members received the required number of hours of OSHA training.

____
____
____

FIELD CHECKLIST

FIELD OBSERVATIONS

Yes _ No _ N/A _ 1. Was permission granted to enter and inspect the facility (required if RCRA inspection)?

____
____
____

Yes _ No _ N/A _ 2. Is permission to enter the facility documented? If yes, where is it documented?

____
____
____

Yes _ No _ N/A _ 3. Were split samples offered to the facility If yes, was the offer accepted or declined?

____
____
____

Yes _ No _ N/A _ 4. Is the offering of split samples recorded? If yes, where is it recorded?

____
____
____

Yes _ No _ N/A _ 5. If the offer to split samples was accepted, were the split samples collected? If yes, how were they identified?

____
____
____

Yes _ No _ N/A _ 6. Are the number, frequency and types of field measurements, and observations taken as specified in the project plan or as directed by the project coordinator? If yes, where are they recorded?

____
____
____

Yes _ No _ N/A _

7. Are samples collected in the types of containers specified for each type of analysis? If no, what kind of sample containers were used?

____
____
____

Yes _ No _ N/A _

8. Are samples preserved as required? If no or N/A, explain.

____
____
____

Yes _ No _ N/A _

9. Are the number, frequency, and types of samples collected as specified in the project plan or as directed by the project coordinator? If no, explain why not?

____
____
____

Yes _ No _ N/A _

10. Are samples packed for preservation when required (i.e., packed in ice, etc.)? If no or N/A, explain why.

____
____
____

Yes _ No _ N/A _

11. Is sample custody maintained at all times? How?

____
____
____

Yes _ No _ N/A _

12. Is the following information completed on each chain-of-custody record?

- Sample identification number;
- Sample collector's signature;
- Date and time of collection;
- Place and address of collection;
- Waste sample description;
- Shipper's name and address;
- Name and address of organization(s) receiving sample;

- Signatures and titles of persons involved in chain-of-possession; and
- Inclusive dates of possession for each possession.

Yes _ No _ N/A _

13. Does a sample analysis sheet accompany all samples on delivery to the laboratory sample custodian?

Yes _ No _ N/A _

14. At the minimum, has the following information been completed on each sample analysis request sheet?

- Name of person receiving sample (sample custodian);
- Laboratory sample number;
- Date of sample receipt;
- Sample allocation;
- Analyses to be performed;
- Collector's name, affiliattion name, address, and phone number;
- Date and time of sampling;
- Location of sampling; and
- Special handling and/or storage requirements.

Yes _ No _ N/A _

15. Has a field custodian been assigned for sample recovery, preservation, and storage until shipment?

Yes _ No _ N/A _

16. Where applicable, are sample collection containers rinsed three times with the sample material prior to collection?

Yes _ No _ N/A _

17. Are glass containers with Teflon-lined screw caps used to collect the following types of samples?

- Water samples for organic analyses?
- Soil and sediment samples?
- Liquid and solid hazardous waste samples (*)?

____
____
____

Yes _ No _ N/A _

18. Are polyethylene bottles with solid polyethylene-lined caps used to collect the following types of samples?

- Water samples for metal analysis?
- Water samples for pH and fluoride analysis?
- Water samples for cyanide analysis?

____
____
____

Yes _ No _ N/A _

19. Are amber glass or aluminum foil-wrapped glass bottles used for samples suspected of being photosensitive?

____
____
____

* Highly alkaline wastes and wastes known to contain hydrofluoric acid should be collecte in plastic containers. If it is suspected that highly alkaline materials or hydrofluoric acid is present, a small sample should be tested to determine if it reacts with the sample container.

QUALITY ASSURANCE/QUALITY CONTROL

SAMPLE DOCUMENTATION AND CHAIN-OF-CUSTODY

Yes _ No _ N/A _

1. Is the following information being recorded in the field log book or on data sheets?

- Project name and project number;
- Purpose of sampling (e.g., quarterly sampling, resample to confirm previous analysis, initial site assessment, etc.;
- Date and time each sample was collected;
- Date and starting/stopping times (Hr:Min) for air samples;
- Date and well bailing time for groundwater;
- Blank, duplicate and split sample identification numbers;
- Sample description including type (i.e., soil, sludge, groundwater, etc.);
- Field measurement results (i.e., conductivity, pH, dissolved oxygen, combustible gas (e.g., LEL), radioactivity, etc.);
- Preservation method for each sample;
- Type and quantity of containers used for each sample;
- Weather conditions at time of sampling;
- Photographic log identifying subject, reason for photograph, date, time, direction in which photograph was taken, number of the picture on the roll;
- Sample destination;
- Analyses to be performed on each sample;
- Reference number from all forms on which the sample is listed or labels attached to the sample (i.e., chain-of-custody, bill of lading or manifest forms, etc.);
- Name(s) of sampling personnel; and
- Signature of person(s) making entries on each page.

Yes _ No _ N/A _

2. Is a chain-of-custody record completed for all samples collected?

CHECKLIST FOR MECHANICALLY CORED SAMPLES

Yes _ No _ N/A _

1. Was the rig set up at a staked and cleared borehole location?

____
____
____

Yes _ No _ N/A _

2. Was the location, date, time, and other pertinent information recorded on boring log form?

____
____
____

Yes _ No _ N/A _

3. Was polybutyrate core tubes cut to specification and placed into core barrel?

____
____
____

Yes _ No _ N/A _

4. Was augering and coring conducted according to the following sequence: 0-1 ft, 1-4 ft, 4-5 ft, 5-9 ft, and 9-10 ft, etc.?

____
____
____

Yes _ No _ N/A _

5. Was the core barrel removed from the borehole and opened at the completion of each coring interval?

____
____
____

Yes _ No _ N/A _

6. Was the 12-inch sections for laboratory analysis removed, capped with Teflon film lined plastic caps, sealed with tape, and immediately placed in a cooler?

____
____
____

Yes _ No _ N/A _

7. Were core sections which were previously etched length-wise taped with plastic caps to prevent opening during transport to the support facility?

Yes _ No _ N/A _

8. Were the polybutyrate line sections marked with an arrow to the top end, the boring number, and depth interval? Was a label giving the same information as well as the project name, number, the date, and the sampler's initials attached to the core in the sample handling trailer or at the site?

Yes _ No _ N/A _

9. Were clean polybutyrate liners placed in a clean core barrel for each additional coring increment to be drilled?

Yes _ No _ N/A _

10. Did the boring reach a predetermined depth or encounter the water table, whichever came first?

Yes _ No _ N/A _

11. For trench disposal areas was the coring performed to the maximum depth of observable contamination?

Yes _ No _ N/A _

12. Were all core sections transported to the support facility for logging and sample shipment preparation?

Yes _ No _ N/A _

13. Was the boring stake left in the ground adjacent to the borehole and a board placed over the hole until it was grouted?

____
____
____

Yes _ No _ N/A _

14. Were all boreholes greater than 1 ft in depth grouted the same day of construction and the borehole location stake placed in the grout?

____
____
____

Yes _ No _ N/A _

15. Were one foot deep borings backfilled with native materials available adjacent to the boring?

____
____
____

Yes _ No _ N/A _

16. Were the augers, and other downhole equipment decontaminated in the field prior to moving to the next borehole location upon completion of each boring?

____
____
____

Yes _ No _ N/A _

17. When all borings in a specific source were completed was the drill rig initially cleaned at the source location?

____
____
____

Yes _ No _ N/A _

18. Upon completion of the initial cleaning was the drill rig transported to the decontamination pad where it was thoroughly steam-cleaned before entering another source area?

____
____
____

Yes _ No _ N/A _

19. Were enough augers and core barrels available so that when one set was in use a second set was being decontaminated?

Yes _ No _ N/A _

20. At the end of the working day did all equipment, except the drill rig, and personnel proceed to the decontamination pad where decontamination procedures were initiated?

Yes _ No _ N/A _

21. Were all bore cuttings drummed and stored while awaiting USATHAMA's directions for disposal?

CHECKLIST FOR HAND CORED SAMPLES

Yes _ No _ N/A _

1. Was a piece of Teflon film and plywood placed over the top of the polybutyrate tube and the tube pushed or driven into the ground by hand?

____
____
____

Yes _ No _ N/A _

2. Was the tube removed from the ground by shovel, the tube exterior wiped clean, the ends capped with Teflon film lined plastic caps, and sealed with tape?

____
____
____

Yes _ No _ N/A _

3. Were the sample tubes marked with the boring number, the depth of the interval sampled, and the upward direction?

____
____
____

Yes _ No _ N/A _

4. Was a label containing the same information written on the sample tube as well as the project name, number, the date, and sampler's initials taped to the outside of the core?

____
____
____

Yes _ No _ N/A _

5. Were cores logged and stored in a cooler with commercially available Blue Ice prior to and during transport to the support facility sampling area where they were logged for shipment?

____
____
____

FIELD CHECKLIST

DOCUMENT CONTROL

Yes _ No _ N/A _

1. Have all unused and voided accountable documents been returned to the coordinator by the team members?

Yes _ No _ N/A _

2. Were any accountable documents lost or destroyed? If yes, have document numbers of all lost or destroyed accountable documents been recorded and where are they recorded?

Yes _ No _ N/A _

3. Are all samples identified with sample tags? If no, how are samples identified?

Yes _ No _ N/A _

4. Are all sample tags completed (e.g., station number, location, date, time, analyses, signatures of samplers, type, preservatives, etc.)? If yes, describe types of information recorded.

Yes _ No _ N/A _

5. Are all samples collected listed on a chain-of-custody record? If yes, describe the type of chain-of-custody record used and what information is recorded.

Yes _ No _ N/A _

6. If used, are the sample tag numbers recorded on the chain-of-custody documents?

Yes _ No _ N/A _

7. Does information on sample tags and chain-of-custody records match?

Yes _ No _ N/A _

8. Does the chain-of-custody record indicate the method of sample shipment?

Yes _ No _ N/A _

9. Is the chain-of-custody record included with the samples in the shipping container?

Yes _ No _ N/A _

10. If used, do the sample traffic reports agree with the sample tags?

Yes _ No _ N/A _

11. If required, has a receipt for samples been provided to the facility (required by RCRA)? Describe where offer or a receipt is documented.

Yes _ No _ N/A _

12. If used, are blank samples identified?

Yes _ No _ N/A _

13. If collected, are duplicate samples identified on sample tags and chain-of-custody records?

Yes _ No _ N/A _

14. If used, are spiked samples identified?

Yes _ No _ N/A _

15. Are logbooks signed by the individual who checked out the logbook from the project coordinator?

Yes _ No _ N/A _

16. Are logbooks dated upon receipt from the project coordinator?

Yes _ No _ N/A _

17. Are logbooks project-specific (by logbook or by page)?

Yes _ No _ N/A _

18. Are logbook entries dated and identified by author?

Yes _ No _ N/A _

19. Is the facility's approval or disapproval to take photographs noted in a logbook?

Yes _ No _ N/A _

20. Are photographs documented in logbooks (e.g., time, date, description of subject, photographer, etc.)?

Yes _ No _ N/A _

21. If film from a self-developing camera is used, are photos matched with logbook documentation?

____
____
____

Yes _ No _ N/A _

22. Are sample tag numbers recorded? If yes, describe where they are recorded.

____
____
____

FIELD CHECKLIST

DEBRIEFING WITH PROJECT COORDINATOR

Yes _ No _ N/A _

1. Was a debriefing held with project coordinator and/or other participants?

____
____
____

Yes _ No _ N/A _

2. Were any recommendations made to the project participants during the debriefing? If yes, list recommendations.

____
____
____

Yes _ No _ N/A _

3. Was a copy of the field checklist left with the project coordinator at the conclusion of the debriefing?

____
____
____

APPENDIX G

LABORATORY AUDIT CHECKLIST

LABORATORY AUDIT CHECKLIST

____
EVALUATED LABORATORY

____
SUBJECT PROJECT

QC Coordinator ______________________

Analytical Task Manager ______________________

Project Manager ______________________

Project Officer ______________________

Evaluator ______________________

Evaluation Date ______________________

AUDIT CHECKLIST

	YES	NO	COMMENT
PRE-AUDIT			
1. Notified laboratory			
2. Notified project officer			
3. Made travel arrangements			
4. Reviewed background information/ data			
5. Requested laboratory to have data/ methods/personnel available			
6. Prepared agenda			
IN-BRIEFING			
7. Introduced participants			
8. Described goals and objectives of audit/agenda			
9. Identified specific areas for review that could require some laboratory preparation			
10. Discussed general overview/status on project			
11. Discussed problem areas			

	YES	NO	COMMENT

GENERAL

12. a. Has detailed Project QC Plan (QAPjP) been submitted?

    b. Has individual been appointed as QAC who is independent from analysis?

    c. Have sufficient facilities, personnel, and instrumentation been provided to perform the required analyses?

    d. Does the QAC have the resources to function effectively?

    e. Are chemicals and reagents of sufficient quality so as not to compromise the analytical system?

    f. Is housekeeping commensurate with analytical techniques?

    g. Has a training plan been developed and training been documented?

    h. Is the correct version of USATHAMA supplied software being used?

AUDIT	YES	NO	COMMENT

13. Samples chosen to follow through laboratory:

    Inorganic

    Organic

14. Sample receiving:

    a. Are procedures/SOPs available?

    b. Are samples checked upon receipt?

    c. Is the sample checking documented?

    d. Is area secure?

    e. Are chain-of-custody forms filed?

    f. Are internal chain-of-custody forms generated?

    g. Are samples logged in according to SOP?

    h. Are USATHAMA numbers assigned?

    i. Are numbers allocated for QC samples?

AUDIT (cont) YES NO COMMENT

j. Are samples stored in refrigerator until needed?

k. Is the temperature of refrigerator monitored?

l. Is there a sign-out system for samples?

m. Are VOA samples isolated from other samples?

15. Inorganics Section:

a. Are logbooks kept for:

Digestion?

Analysis?

Instrument maintenance?

Standard preparation?

b. Are logbooks identified with unique number?

c. Are pages of logbooks numbered?

d. Are reagents/solvents/acids checked for purity, etc.?

Inorganics (cont)	YES	NO	COMMENT
e. Are standards stored correctly?			
f. Is inventory of standards maintained?			
g. Are standard solutions labelled with date prepared?			
h. Are solution validity checks documented?			
i. Are standards traceable from receipt to use?			
j. Are samples maintained and stored according to SOP?			
k. Are procedures in place to minimize cross contamination?			
l. Are samples analyzed according to certified methods?			
m. Are results of analyses stored in data packages?			
16. Organics Section:			
a. Are logbooks kept for:			
Extraction?			
Analysis?			

Organics Section (cont)	YES	NO	COMMENT
Instrument Maintenance?			
Standard preparation?			
b. Are logbooks identified with unique number?			
c. Are pages in logbooks numbered?			
d. Are reagents/chemicals checked for purity, etc.?			
e. Are standards stored correctly?			
f. Is an inventory of standards maintained?			
g. Are standard solutions labelled with date prepared?			
h. Are solution validity checks documented?			
i. Are standards traceable from receipt to use?			
j. Are samples maintained and stored according to SOP?			
k. Are procedures in place to minimize cross contamination?			

Organics (cont)	YES	NO	COMMENT
l. Is tuning of GC/MS performed and documented every 12 hours?			
m. Are samples analyzed according to certified methods?			
n. Are results of analyses stored in data packages?			
17. Method selected is performed according to written certified method?			
18. Have problem areas been discussed and corrective actions reviewed/ recommended?			
19. Data Management:			
a. Data packages prepared for each lot of analysis?			
b. Data packages readily available for review?			
c. Representative data packages from each method reviewed?			
d. Data package checklists included in each package?			
Filled out correctly?			
e. Notebook pages signed and dated?			

Data Management (cont)	YES	NO	COMMENT
f. Computer print-outs readily identified?			
g. Data processing according to SOPs?			
h. Data transmittal to USATHAMA according to SOPs?			
20. Has data been validated according to USATHAMA internal SOP?			
OUTBRIEFING			
21. Summary given on findings, observations, conclusions reached?			
22. Responded to laboratory questions/ concerns?			
23. Provided forum to rectify differences between laboratory staff and audit team?			
24. Identified deficiencies and offered assistance in their correction?			
25. Copy of completed audit checklist provided to laboratory?			
26. Discussed future goals and objectives?			

APPENDIX H

WATER APPROVAL REQUEST FORM

WATER APPROVAL REQUEST FORM

ARMY INSTALLATION FOR INTENDED USE:

1. Water source:

   Owner:
   Address:
   Telephone number:

2. Water tap location:

   Operator:
   Address:

3. Type of source:

   Aquifer:
   Well Depth:
   Static water level from ground surface:
   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by owner/operator:

7. Attach results and dates of chemical analyses for past two years. Include name(s) address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:
Period:
Telephone number:
Date:

USATHAMA APPROVAL (A)/DISAPPROVAL (D): (Check one)

Project officer:	A	D
Project geologist/date:	A	D
Project chemist/date:	A	D